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# WHY THE MOCKING BIRDS LEFT NEW JERSEY—A GEOLOGICAL REASON.[1]

BY SAMUEL LOCKWOOD, PH. D.

Is it not "past the infinite of thought?" Even though expressed in numbers, who has a mental grasp of the stellar distances? And equally inadequate is the time conception of any working æon taken by nature in sculpturing the features of our Mother Earth. Still, though we may do no better than conjecture the time of any special fashioning, so dim is the distance, yet the geologic record makes clear the fact that the sea coast of New Jersey formerly extended very much farther into the Atlantic than it does to-day. In taking soundings off the coast the lead will drop suddenly into deep gorges in the ocean bed, thus revealing, as it were, an oceanic valley nearly parallel to the coast line. Though about a hundred miles south-east of the present mouth of the Hudson, this seems to denote the ancient outlet of the river into the sea. All this is in accord with the facts known concerning the subsidence of the New Jersey coast. Even when Hudson saw them, the Highlands of Navesink were somewhat higher than now, hence with the Squan Highlands, the first land sighted by homing vessels, were visible further out at sea. These

[1]Read at the Ninth Congress of the American Ornithologists' Union in New York, Nov. 16, 1891.

Monmouth Highlands mark the extreme south and north points of the county coast line; for the rest, the New Jersey shore is mainly a sandy flat, which formerly was thickly fringed with evergreens, much of it being cedar and cypress, though the prominences mentioned were densely wooded with deciduous trees.

In the southern part of the State exists a curious industry—the mining for cedar—exhuming from their swampy burials the white cedars, *Cupressus thyoides*. Some of these noble trees much exceeded three feet in diameter, with the timber perfectly sound. "The lay" of these uprooted trees indicates the devastation probably of extraordinary cyclones occurring at immense intervals of time, thus leveling one forest upon another that had been thrown long before. Even the cedars standing there to-day are a growth over their long buried ancestors. Of two at least of these buried forests beneath the present growth the evidence is indisputable. Counting the season rings some of these exhumed trees must have taken 1500 and possibly 2000 years to grow. But I am not especially concerned with the question of time—it is the fact of subsidence.

And this action is still in progress. Nay, some notable instances there are which present phenomena appealing to our eyes. On the south side of Raritan Bay, or rather Keyport Bay, which is simply an indenture of Raritan, is a clay bluff that in my own recollection has lost much in altitude. Standing on this eminence some ten or twelve feet higher than the line of high tide, I have seen at times of very low tide, in the distance, stumps of trees, in the same position in which they were left by the woodman's axe when he cut down the forest or grove which grew on that bluff when it reached much farther seaward than now. And perhaps even stranger still, a little north of this, and something nearer the shore, I once saw a great number of broken bricks and a well-curb, the remains, as I learned, of a brick yard, which, like the ancient bluff, had also gone to sea. But I will leave this for a moment.

During a residence of many years at Keyport, N. J., which is not more than two miles from the bluff, I had cherished a little grove of native saplings. They were all seedlings and self-planted. There were scrub oaks, pines, persimmons and a group of bilsteds, or gum trees.

The last attained a considerable height, and all together made a dense covert, in which I took great delight. My pleasure was enhanced by its being a resort for robins, catbirds and some smaller birds. I had thus some good bird music, especially mornings and evenings. It was a summer eve in 1882 when a *Mimus polyglottus* took possession of my cherished grove and opened with a budget of bird music which astonished me. His répertoire was so voluminous and of such variety; indeed, it was a mélange of bird song. The voice was ringing and clear with a quality which I can only call golden. The performance was certainly snatchy, but so rollicking, rapid and impromptu like. The strange thing appeared to me a phenomenon—an avian improvisatoire gone stark mad. Such a bubbling stream of ornithic song—such reckless impetuosity, such phonic exuberance, such imperious audacity of utterance—this defiant monopolist of bird music held me enthralled. It was the first time I had ever heard a wild mocker in the woods. The wonderful creature regaled me in the same grove for six consecutive evenings, then was heard no more. The impression was made on me that my robins and catbirds were also profoundly affected, for on each evening when this grand mæstro sang they observed that respectful silence which is the homage due to superiority.

This incident set me upon inquiry. I found an old man who was born in the last century—a native who had spent his entire life near the bluffs already mentioned. In the parlance of the day "we interviewed" him; hence the dialogue as nearly as can be must be reported.

"How long have you lived in these parts?"

"All my life. Leastwise was never away long at a time."

"Did you ever know of any mocking birds about here?"

"Not of late years, but plenty of 'em when I was a lad.

Many's the time I've gone nesting for them in the cedars that used to be yonder."

"What do you mean by the cedars that used to be yonder?"

"On the bluffs just over there (pointing to the Bay). Sixty year ago that bank was a good deal higher than now, and reached a sight further into the Bay, though the tide comes up just as close as it ever did. But there's a mighty big change there. There used to be a thick forest of red cedar on the bluff, and the mockers, a plenty of them, built there every summer, and there was no trouble in finding a few nests. But there's not been a single cedar there for many years—just how long I disremember. You see the bluff got going to sea so fast they had to cut the cedars to save them. You can see the stumps yet at almost any neap tide. It 'most beats belief that the bluffs ever reached so far as them stumps. Why in my time a pretty good farm has gone off to sea. There used to be a brick yard—that has gone off too. It lay a little north of them cedars, and something can be seen of it when the tide suits. Old Auntie Willets, now dead and gone, used to milk the cows along side of what we called the black rock. That's gone too, and I should think it has sunk considerable, for it's little more than the top of it that one can see at neap tide."

I was surprised at the amount of geology I was abstracting from my informant, and felt that he was getting away from the subject in hand, so I asked: "Have you seen any mocking birds in these parts of late years?"

"Not one in many years as I can remember. The woods don't seem to favor them now. In the time of the cedars they were plenty."

To the old man the word "subsidence" incautiously used by me had no meaning. He had a reason of his own. "Naturally the sea was uprising, sort of overflow on the land. Was it not all the time receiving the waters of all the rivers in the world without any let-up whatever?"

It was some thirty years ago, perhaps more, when I accompanied the late Prof. George H. Cook, the State Geologist, in an inspection of the entire south side of Raritan Bay, my

recollection is that the Professor estimated the present subsiding as proceeding at the rate of a vertical half inch in a year, and the Doctor had gathered other very interesting data, such as the change of level of tide-water mills. The rate stated is certainly enormous when compared with the time taken to produce the subsidence of the cedar swamps or mines.

The cypress and the cedar, also the arbor-vitæ, but especially the former, loved the sandy levels of the New Jersey coast. But with subsidence and the woodman's axe very little of these sheltering copses of evergreens is left. Forty years ago an occasional pair of mockers has been known, even in the central part of the State by a stream in a deciduous tkicket, with catbriers interlaced. But the bird even then was rare—and is much rarer now. The hospitable shelters and food resources on the shores are gone, and the mocker has virtually left also. The bird has yielded to the fiat of geological change—the inevitable law to which the flora and the fauna of the earth must bow.

Our position is not that these birds can no longer live in New Jersey, but that the situation is less inviting than formerly; in a word, the bird life is harder. As to shelter and food, the old summer home has become less hospitable. There is a third factor beyond reach in this discussion, that of climate. True, we do know something of this as caused by the denuding of the land of its native forests; but we know nothing of that climate when the shores of the State, far-reaching into the sea, hugged more closely the thermal Gulf-stream. It will appear too, that we have taken no note of the effect of contact with civilization, which in the main is less conservative than even geologic change.

In the dialectics the principle is accepted that the exception may establish the rule. This, though often true in the mental realm, is but rarely so in that of the physical. Hence it is not only interesting but quite remarkable to find our position fortified by a geological exception, almost on the spot which has come directly under our review. Raritan Bay is in part bounded by the little peninsula of Sandy Hook. While the main is suffering from subsidence of the land and denudation

of the forests, Sandy Hook is increasing in both these respects. It is lengthening out without narrowing, and maintaining, protected from the axe, a dense and increasing growth—a fine virgin forestage on its sandy beaches of the very tree flora which has so nearly departed from the flats of the State. We have there also at least nearly the climate which with such shelter prevailed over the mainland, where now is the inhospitable bleakness of the naked beach. Æolic action is keeping up an undertow on the coast line, carrying to the Hook and depositing a part of the very material which subsidence and tidal wash is stealing from the shore southward. And so dense is the growth of cedars, with grand outliers of the crimson berried hollys, that not only are these evergreen groves opulent in food, but also practically impervious to the winter winds. Here are rookeries of crows, which almost blacken the air as they return in the evening from their daily foraging. Here, too, are robins by "the thousands," both summer and winter. And here too in this bird paradise has our *Mimus polyglottus*, summer and winter, as far back as the memory of man goeth, found a hospitable home. With warm housing and a generous board a fig for "the sunny South." With desire satisfied the migratory instinct has died out.

Let me close with a little avian episode. At Sandy Hook is a military establishment for cannon practice and testing the new monster ordnance and projectiles. So bold and familiar are these birds that they seem not to mind the flying and exploding shells. The wife of the superintendent, having found a nest of mocking birds, made it frequent visits, to which the parent birds seemed not to object. The lady's interest in her find increased, and when the young became fledglings she removed them from the nest to a cage and brought them up as pets. To her surprise the old birds kept near the young ones, becoming regular visitors, especially at feeding time, thus sharing with the young the lady's bounty. Their tameness became remarkable. The fully feathered young were allowed their freedom, and parents and offspring would betake themselves to the grove, but would return on call of their benefactress at feeding time, when would ensue a scene of interest

often witnessed by the officers. At the summons—"Mockie, Mockie, Mockie," the entire family would come and alight, even upon the lady, accepting her hospitality and permitting her caresses. All this was kept up through the entire winter. In March, 1888, occurred the great blizzard. This fearful snow storm invaded the retreat of the birds, interpenetrating the hitherto impenetrable asylum. So soon as the storm had subsided the lady went to the woods to look up her little avian friends. Her customary gentle call resounded through the dense grove. But no response came from the mockies. At last her pets were found on the white ground—dead! Thus, too, it befell many others in the colony, which was then on the increase. Happily a remnant survived the storm, so that still, representatively, *Mimus polyglottus* occupies this little elysium so typical of the once grander New Jersey home of his ancestors.

# HEREDITY AND THE GERM-CELLS.

By Henry Fairfield Osborn.

The Cartwright Lectures for 1892, III.

(*Continued from Page 567, Vol. XXVI.*)

According to the general law[1] the germ-cell is considered as matter potentially alive and having within itself the tendency to assume a definite living form in course of individual development. The nucleus must be extraordinarily complex, for it contains within itself not only the tendencies of the present type, but of past types far distant. The supposition of a vast number of germs of structure is required by the phenomena of heredity; Nägeli has demonstrated that even in so minute a space as $\frac{1}{1000}$ cub. millimetre, 400,000,000 micellæ must be present.

The study of heredity will ultimately centre around the structure and functions of the germ-cells. The precise researches of Galton show that the external facts of heredity, questions of averages and of probabilities, of paternal and maternal contributions to the offspring, are capable of being reduced to an exact science in which mathematical calculations will enable us to forecast the characteristics of the coming generation.

There will still remain, however, a large residuum of facts which will present themselves to a mathematician like Galton as chance or inexact, such as the physiological conditions of reversion; the causes of prepotency, by which the maternal or the paternal characteristics prevail in parts or in the entire structure of the offspring; the material basis of latent heritage upon which reversion depends, and which compels us to hypothecate either an unused hereditary substance or a return to an older disposition of the forces in this substance; the nature and determination of sex. These apparently chance

[1]See Huxley, Article Evolution, Enc. Britannica, p. 746.

phenomena must also be due to certain fixed laws, and by far the most promising routes to discovery have already been taken by Van Beneden, the Hertwig brothers, Boveri, Maupas, and others.

They have attacked the problem of the relation of the germ-cells to heredity on every side, and by the most ingenious and novel methods, which are familiar enough in various branches of gross anatomical and physiological research, but seem almost out of the limits of application to minute microscopic objects. For example, the Hertwig brothers have ascertained the influences of various solutions of morphine and other drugs, of the alcohols, and of various degrees of temperature upon the ovum and spermatozoon during the conjugation

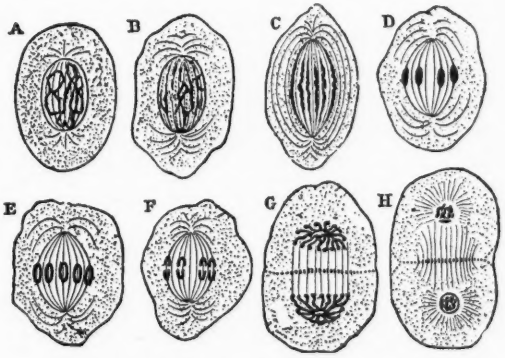


FIG. 7.—TYPICAL CELL DIVISION, SHOWING THE DISTRIBUTION OF CHROMATIN. (From Parker, after Carnoy.) A-C, Arrangement of the chromatin in threads; D-E, Formation of the chromatin rods and loops; F, Splitting of the loops; G-H, Retraction of the chromatin into the two daughter-cells.

period, with results which are highly suggestive of the causes of congenital malformations, anomalies, and double births. The Hertwigs and Boveri have succeeded in robbing ova of their nuclei, and watching the results of the subsequent entrance of spermatozoa. In order to further test the relations of the nucleus to the remainder of the cell, Verworn has experimented along the same line with extirpations of every kind from the single cells of Infusoria. Of equal novelty are

the recent studies of Maupas upon the multiplication and conjugation of the Infusoria, giving us a host of new ideas as to the cycle of life, the meaning of sex, and the origin of the sexual relation.

In all this research and in the future outlook there are two main questions:

1. *What is the hereditary substance?* What is the material basis of heredity, which spreads from the fertilized ovum to every cell in the body, conveying its ancestral characteristics? Is there any substance corresponding to the hypothetical idioplasm of Nägeli?

2. *What are its regulating and distributing forces?* How is the hereditary substance divided and distributed? How far is it active or passive?

I may say at the outset that the idioplasm of Nägeli, a purely ideal element of protoplasm which he conceived of as permeating all the tissues of the body as the vehicle of heredity, has been apparently materialized in the *chromatin* or highly coloring materials in the centre of the nucleus. This rests upon the demonstration by Van Beneden and others that chromatin is found not only in all active cells, but is a conspicuous element in both the ovum and spermatozoon during all the phenomena attending conjugation.

Secondly, that while the chromatin is apparently passive, it is played upon by forces resident in the clear surrounding protoplasm of the nucleus, but chiefly by the extra nuclear *archoplasm*, which seems to constitute the dynamic and mechanical factor in each cell. This, unlike the chromatin, only comes into view when there is unusual activity, as during cell-division, and is not evident (with our present histological technique, at least), when the cell is arrested by reagents in any of the ordinary stages of metabolism.

**The Distribution of Hereditary Substance.**—I may first review some of the well-known phenomena attending the distribution of the chromatin substance to the tissues.

I have borrowed from Parker figures by Carnoy to illustrate the resting and active stages of the cell, and from Watase, a

Japanese student of Clark University, figures representing the high differentiation of the cell-contents during division (figs. 8, 9). They bring out the active and passive elements of the typical cell.

The phenomena of karyokinesis which attend the division and distribution of the hereditary substance throughout the whole course of embryonic and adult development are well illustrated in Carnoy's figures (fig. 7). First we have the qui-

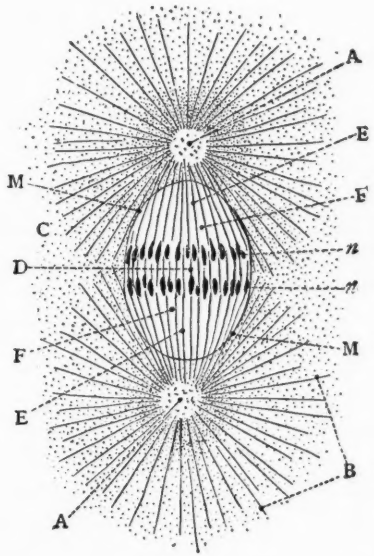


FIG. 8.—BEFORE DIVISION. DIFFERENTIATION OF THE CYTOPLASM AND NUCLEUS DURING CELL DIVISION OF A SQUID EMBRYO, LOLIGO. (After Watase.) M, The nuclear membrane; F, Achromatin or nucleoplasm; C, Cytoplasm, or protoplasm outside of the nucleus; A-A, The two centrosomes of archoplasm, B, Extra-nuclear archoplasmic filaments, E, Intra-nuclear archoplasmic filaments attached to *n*, *n'*, the chromatin rods.

escent period, in which the chromatin presents the appearance of a coiled, tangled thread; surrounding this is the clear nucleoplasm (or achromatin) bounded by the nuclear membrane; the extra-nuclear substance, or cytoplasm, is apparently undifferentiated. As soon as cell division sets in, however, radiating lines are seen in the cytoplasm above and below the

nucleus, these are called the archoplasmic filaments by Boveri, since they proceed from what is now believed to be the dynamic element, the archoplasm (fig. 8). As the activity becomes more intense the filaments are seen to diverge from a centre—the archoplasmic *centrosome*—which lies just without the nucleus at either pole; this radial display of cell-forces suggested the term "asters" to Fol, and "spheres attractive" to Van Beneden. The behavior of the chromatin, or hereditary substance, under these archoplasmic forces, is beautifully shown in Carnoy's diagrams (fig. 7). First, the nuclear wall

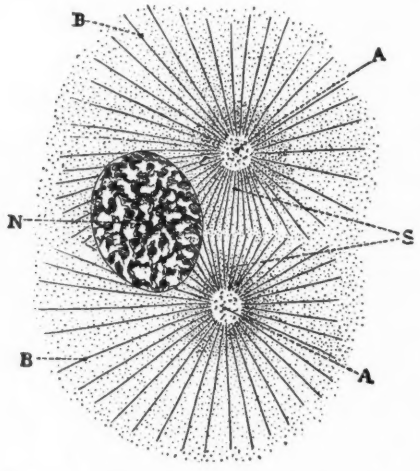


FIG. 9.—AFTER DIVISION. INTERIOR OF A DAUGHTER-CELL IN THE SQUID. (After Watase.) Division has just taken place and the daughter-nucleus, N, shows the chromatin coil. The daughter centrosome is just forming two new centrosomes, A-A, by direct division.

breaks up, then the chromatin coil unfolds into lines of vertical striation which become thread-like, hence the term mitosis, and then more compact, until finally a number of distinct vertical rods, chromatin rods, or *chromasomes* are formed.

A remarkable and significant fact may be noted here, that the number of chromasomes varies in the cells of different species, and even in the cells of different varieties (as in the thread-worm of the horse—*Ascaris megalocephala*), but is con-

stant in all the cells of the same variety through all stages; thus the same number of chromasomes appears in the first segmentation of the fertilized ovum as in the subsequent cell division in the tissues.

Carnoy next indicates the vertical splitting of each rod into a loop or link preceding the horizontal splitting; thus we may conceive of a thorough redistribution of the chromatin before it passes into the daughter-cells. The split loops are each retracted toward a centrosome, suggesting to some authors a contractile power in the archoplasmic filaments; each chromasome being apparently withdrawn by a single filament. But as the chromasomes separate, the filaments also appear between them, and are variously termed "interzonal," "verbindungs Fäden," "filaments réunissant;" there is, therefore, some difference of opinion as to what the mechanics of the chromasome divisions really are. The chromatin is now retracted into two coiled threads, each the centre of the daughter-nucleus with a single centrosome beside it. But as the line of cleavage is drawn between the two cells (fig. 9), the single centrosome in each cell divides so that each daughter-cell is now complete with its chromatin coil and two archoplasmic centrosomes. This process has been beautifully described by Watase.[2]

It thus appears that both the chromatin and archoplasm are permanent elements of the cell, such as we formerly considered the nucleus; the apparently passive chromatin is divided with great precision by the active archoplasm, then the archoplasm simply splits in two to resume the cleavage function.

**Fertilization—The Union of Hereditary Substances.**—Before looking at the host of questions which fertilization suggests, let us review a few of the well-known phenomena preparatory to the union of the germ-cells, in order to give greater emphasis to the importance of recent discoveries.

First, the ovum is a single cell, the typical structure of which, with its nucleus and cytoplasm, is generally obscured

[2]See Marine Biological Laboratory Lectures, 1889. Boston: Ginn & Co.

by a quantity of food-material, surrounded by a rather dense cell-wall. The ovum is said to be ripened or "matured" for the reception of the spermatozoon, by the extrusion of two small "polar bodies," containing both chromatin and hyaline protoplasm, and separating off by karyokinetic division. After maturation is complete, a single spermatozoon normally penetrates; then a reaction immediately sets in in the cell-wall of the ovum, which prevents other spermatozoa from entering. The head of the spermatozoon and the nucleus of the ovum now fuse together to form a single nucleus, which obviously contains the hereditary substance of two individuals. This is the starting point of the segmentation or distribution process above described, and it follows that the fertilized ovum at this stage must contain its typical complement of chromatin, archoplasm, etc., for the whole course of growth to the adult.

How shall we connect these phenomena of fertilization with the facts of heredity? The most suggestive enigma in connection with the fertilization process has been *the meaning of the two polar bodies*, especially since Van Beneden demonstrated that they contained chromatin. For twenty-five years speculation has been rife as to why the ovum should extrude a portion of its substance in two small cells; why not in one cell? Why not in a larger number? Thanks to the intense curiosity which these polar bodies have aroused, and to the great variety of explanations which have been offered for them, we have arrived to-day at a solution which links the higher animals with the lower, breaks down the supposed barrier between the sexes, and accords with the main external facts of heredity.

It seems to me best to disregard the order of discovery, and to state the facts in the most direct way. First, a few words as to the speculations upon the meaning of the polar bodies.

The early views of fertilization[3] were naturally based upon the apparent significance of this process in the human species, in which the sexes are sharply distinguished from each other in their entire structure, and the reproductive cells are also

[3]See also the introduction of Weismann's last essay, Amphimixis.

widely differentiated in form, the ovum large and passive, the spermatozoon small and active. The readiest induction was to regard these elements as representing distinct physiological principles, corresponding to the essential sexual characteristics—in short, as male and female cells, the former vitalizing and rejuvenating the latter. Thus one of the earliest definite "polar-body" theories was that the ovum was hermaphrodite, containing both male and female principles, and that it was necessary to get rid of the male substance before the spermatozoon could enter.

As Von Siebold and Leuckart had demonstrated that some ova reproduce parthenogenetically, that is without fertilization by spermatozoa, Weismann turned to such forms for the solution of this problem, and was surprised to find that parthenogetic ova only extrude one polar body; this led him to attach one meaning to the first polar body and another meaning to the second, which he viewed as designed to reduce the hereditary substance in the ovum without regard to sex. Thus both this and the older theory conveyed alike the idea of *reduction*, but with an entirely different supposition as to the nature of the material reduced or eliminated.

*Maupas on Conjugation among the Infusoria.*[4]—Among the newer researches which throw light upon this old problem those of Maupas are certainly the most brilliant. After a most exact and arduous research, extending over several years, he collected his results in two memoirs, published in 1889 and 1890.

His experiments were first directed upon the laws of direct multiplication by fission, which revealed a complete cycle of life in the single-celled Infusoria and showed that after a long period this mode of reproduction becomes less vigorous, then declines, and finally ceases altogether unless the stock is rejuvenated by conjugation of individuals from different broods. In other words, these broods of minute organisms grow old and die unless they are enabled to fertilize each other by an

[4]Sur la multiplication des Infusoires Ciliés, Archiv de Zoologie expérimentale, Sér. 3, vol. vi, pp. 165–273; Le Rejeunissement Karyogamique chez les Ciliés, vol. vii, pp. 149–517. See also Hartog, Quart. Journ. Microscop. Science, December, 1891.

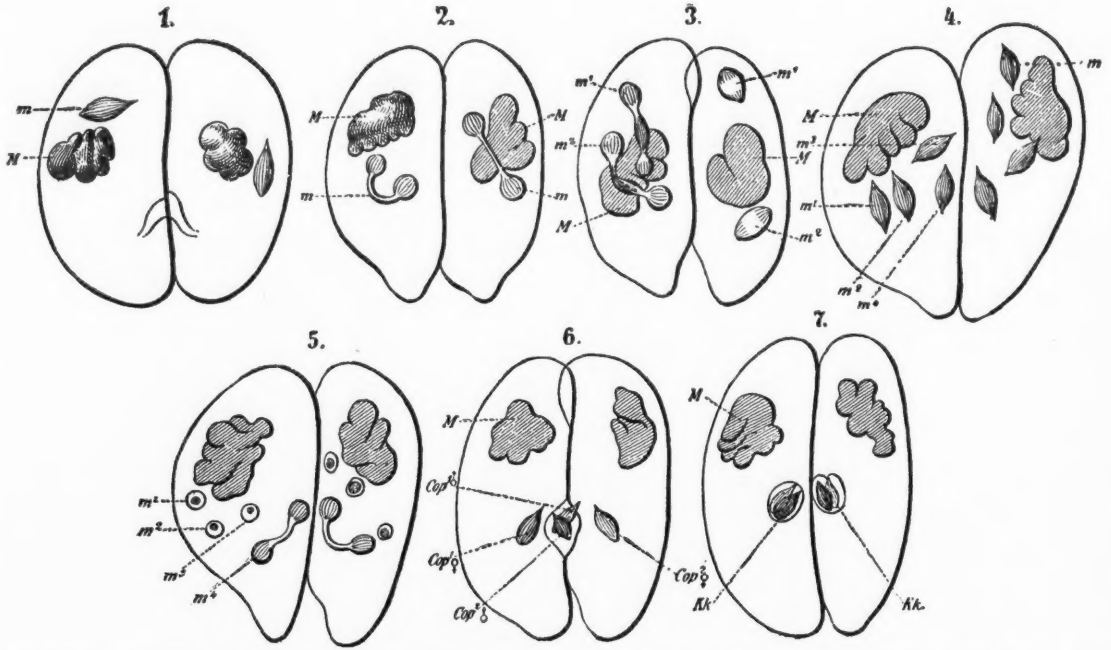


FIG. 10.—THE CONJUGATION OF INFUSORIA. (From Weismann, after Maupas.) 1, Two Infusoria copulating; *M*, meganucleus; *m*, micronucleus; 2-5, Successive divisions of micronuclei; 6, The migration of one of the persisting micronuclei from each infusorian into the other; 7, Union of the interchanged micronuclei.

exchange of hereditary substance altogether analogous to that observed in the higher multicellular organisms.

The cultures were made in a drop of water upon a slide, and feeding was adapted either to the herbivorous or carnivorous habits of the species. Under these conditions it was found that the rate of fission or direct multiplication varied directly with the temperature and food, rising in some species (*Glaucoma scintillans*) to five bipartitions daily. With the optimum of conditions this rate, if sustained for thirty-eight days, would produce from a single individual a mass of protoplasm equivalent to the volume of the sun. This rate is, however, found to be steady for a time, and then the offspring decline into "senescence," in which they appear at times only one-fourth the original size, with reduced buccal wreaths and degenerate nuclear apparatus. This is reached sooner in some species than in others; *Stylonichia pustulata* survives three hundred and sixteen generations or fissions, while *Leucophrys patula* persists to six hundred and sixty generations. Finally, even under the most favorable condition of environment, death ensues.

Not so where conjugation is brought about by mingling the offspring of different broods in the same fluid, as in the natural state. Maupas soon discovered that exhaustion of food would induce conjugation between members of mixed broods. He thus could watch every feature of the conjugation process, and determine all the phases in the cycle of life. These differed, as in the longevity of the species. In *Stylonichia*, for example, "immaturity" extended over the first one hundred bipartitions; "puberty," or the earliest phase favorable to conjugation, set in with the one hundred and thirtieth bipartition; "eugamy," or the most favorable conjugation phase, extended to the one hundred and seventieth; then "senescence" set in, characterized by a sexual hyperæsthesia in which conjugation was void of result or rejuvenescence, owing apparently to the destruction of the essential nuclear apparatus.

Conjugation begins with the approach of two individuals, and adhesion by their oral surfaces. There is no fusion, but an immediate transformation in the cell contents of each indi-

vidual sets in, concluding with an interchange of nuclear substance. In each cell Maupas distinguishes between the (*M*) *meganucleus* (fig. 10, the macronucleus, nucleus, endoplast of authors), which presides over nutrition and growth and divides by constriction, and the (*m*) *micronucleus* (paranucleus, nucleolus, of authors), which presides over the preservation of the species. The latter contains chromatin; it is the seat of rejuvenescence, the basis of heredity, it divides by mitosis, showing all the typical stages of karyokinesis excepting the loss of the cell membrane.

The transformation in each of these copulating cells first affects the centres of hereditary substance, viz., the micronuclei; they divide three times; thus the micronuclear substance is reduced to one-fourth of its original bulk. It is contained in two surviving micronuclei (the others being absorbed or eliminated), one of which migrates into the adjoining cell; the other remains stationary. This migration is followed by a fusion of the migrant and stationary micronuclei; this fusion effects a complete interchange of hereditary substance, after which the two Infusoria separate and enter upon a new life cycle. Meanwhile the meganucleus breaks up and is reconstituted in each fertilized cell.

Maupas gathers from these interesting phenomena additional proof that the chromatin of all cells bears the inherited characteristics and that the cytoplasm and nucleoplasm, or achromatin, is the dynamic agent, because the micronuclei bearing the chromatin are the only structures which are permanent and persistent, all the other structures—nucleoplasm, archoplasm, etc.—being replaced and renewed. The reduction of the chromatin is purely quantitative, the eliminated and fertilizing micronuclei being exactly equivalent; after the chromatin has been quartered the cell becomes incapable of further activity until it is reinforced by chromatin from the copulating cell.

*No Distinction Between the Sexes in Heredity.*—The three laws which underlie these phenomena are: 1. That fertilization consists in the union of the hereditary substance of two individuals. 2. That before union the hereditary substance in

each is greatly reduced. 3. That there is no line between male and female, the conjugating cells are simply in a similar physiological condition wherein a mingling of hereditary characteristics affords a new lease of life. As Maupas says:

"Les différences appelées sexuelles portent sur des faits et des phénomènes purement accessoires de la fécondation. La fécondation consiste uniquement dans la réunion et la copulation de deux noyaux semblables et équivalents, mais provenus de deux cellules distinctes."

In this conclusion as to the secondary and superficial, rather than fundamental, difference between the two sexes, Maupas simply confirms the views of Strasburger, the botanist, Hensen, R. and O. Hertwig, Weismann, and others, namely, that sex has evolved from the necessity of cell conjugation; that even in the higher forms the cells borne by the two sexes are absolutely neutral so far as sex is concerned, the wide difference of form of the germ-cells is a result of physiological division of labor—the mass and yolk of the ovum having been differentiated to support the early stages of development, while the spermatozoon has dispensed with all these accessories and acquired an active vibratile form for its function of reaching and penetrating the ovum. The evidence of the Infusoria is paralleled among some of the plants, in which conjugation between entirely similar cells is observed.

The causes finally determining sex may come surprisingly late in development, and according to the investigations of Düsing and the experiments of Yung[5] and of Giron are directly related to nutrition. High feeding favors an increase of the percentage of females, while, conversely, low feeding increases the males. In Yung's experiments with tadpoles the following results were obtained:

| | Females. | Males. |
|---|---|---|
| Normal percentage..... | 57 | 43 |
| High nutrition..... | 92 | 8 |

[5]See Geddes and Thomson: The Evolution of Sex, 1891, also, Düsing: Die Regulierung des Geschlechtsverhältnisses bei d. Vermehrung der Menschen, Tiere und Pflanzen, Jen. Zeit. f. Natur., Bd. 17, 1884.

Geddes expresses this principle in physiological terms of metabolism, that anabolic (constructive) conditions produce females, while katabolic (destructive) conditions produce males.

I think we may now safely eliminate the factor of sex from our calculations upon the problem of heredity, and thus rid ourselves of one of the oldest and most widespread fallacies. We shall thus, in using the terms "paternal" and "maternal" imply merely the distinction between two lines of family descent.

*The Theory of Reduction.*—This leads us back to the significance of the polar bodies. Van Beneden's discovery that these

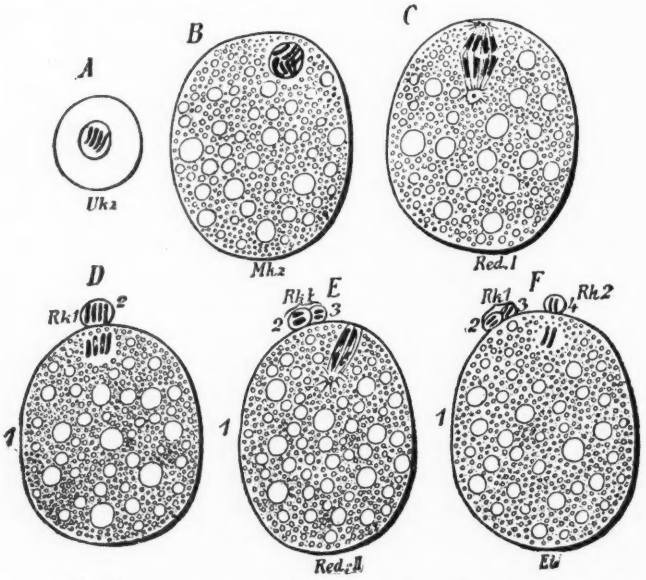


FIG. 11.—THE MATURATION OF OVA, OR FORMATION OF POLAR BODIES IN ASCARIS. (From Weismann after Hertwig.) A, original germ-cell in embryonic germ-layer—4 chromatin rods; B, Ovum mother-cell—8 rods; C-D, First polar body extruded; E, Splitting of first polar body. Ovum still contains 4 rods; F, Second polar body extruded; Ovum mature with 2 rods.

bodies contained chromatin led gradually to the view that they were not fragments of the ova, but represented minute morphologically complete cells. Bütschli showed that they were

given off independently of, and prior to, the contact of the spermatozoon, and, finding in the leeches that the first polar body subdivides to form two bodies, he considered them as formed by true cell division, and containing both nucleoplasm and chromatin. Giard independently reached a similar opinion, assigning an atavistic meaning to the polar cells. Whitman, in 1878, advanced the idea that they represented vestiges of the primitive mode of reproduction by fission, while Mark described them as "abortive ova."

At this point speculation subsided until it was revived by Weismann's attempt to connect these bodies with his theory of heredity,[6] already referred to. The whole history is clearly given in R. Hertwig's masterly memoir upon Ovo and Spermatogenesis in the Nematodes.[7] Taking advantage of Boveri's discoveries in staining technique, and stimulated by Weismann's prediction that spermatozoa would also be found to extrude polar bodies, this author examined all stages in the peculiarly favorable germ-cells of the thread-worm of the horse (*Ascaris megalocephala*).

He made the surprising discovery that ova and spermatozoa are formed in a substantially similar manner by repeated divisions, the single difference being that the last products of division among the sperm-cells are effective spermatozoa, capable of development in fertilization, while the last products of division in the ovary are, first, the true ova, and second, the abortive ova (polar cells) incapable of development. In both ova and spermatozoa the nucleus contains but one-half the chromatin which a typical nucleus contains; in the case of *A. megalocephala* each of the germ-cells contains but two chromasomes while the normal body-cells contain four. The manner in which this maturation of the germ-cells for conjugation is brought about is beautifully shown in these diagrams, taken from Weismann's essay, "Amphimixis." You observe that the number of chromasomes in the primary germ-cells is four (figs. 11 and 12, *A*). Then are formed by subdivision the ovum and sperm "mother-cells," in which the chromatin substance

[6] On the Number of Polar Bodies and their Significance in Heredity. 1887.

[7] Ei- und Samenbildung bei Nematoden, Archi. mikr. Anat., Bd. 26, 1890.

is doubled, so that we observe eight chromasomes. The mother-cells then divide and the chromatin is reduced to four rods, a second division rapidly follows whereby the chromatin is reduced to two rods, or half the original quantity. These last divisions take place by karyokinesis, but, as Hertwig points out, they differ from typical karyokinesis in the fact that the divisions follow so rapidly upon each other that the vesicular

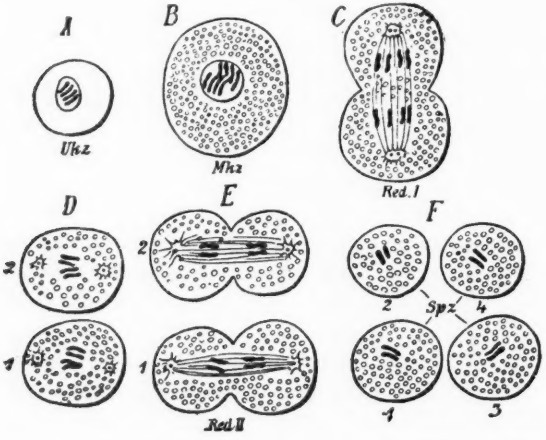


FIG. 12.—SPERMATOGENESIS IN ASCARIS. (From Weismann after Hertwig.) A, Original germ-cell—4 chromatin rods; B, Sperm mother-cell—8 rods; C-D, First daughter-cells with 4 rods each; E-F, Formation of second daughter-cells, or mature spermatozoa, with 2 rods each.

resting-period of the nucleus is omitted. Thus, he suggests, is prevented an over-accumulation of chromatin substance prior to the fusion of the ovum and sperm.

It is evident that the polar-cells are rudimentary ova, which do not possess the yolk-mass, etc., essential to development, and are divided off at a very late stage, sometimes after the egg has left the ovary, but are in other respects analogous to the spermatozoa. The reason these polar-cells have not disappeared altogether in either plants or animals is that they originally possessed a deep physiological importance. As the first polar-cell subdivides and forms two, it follows that from both ovum and sperm mother-cells four daughter-cells are

formed, each containing half the chromatin substance of a normal nucleus. In the ovary three of these daughter-cells abort and the fourth forms a true ovum; in the sperm-gland, however, all four daughter-cells form spermatozoa.

We may thus consider the polar-cell problem as in all probability settled; the whole process is probably an inheritance or survival of a primitive condition in which all four ova, like the four spermatozoa, were fully functional.

*The Relation between the Chromatin and Heredity.*—We have just seen that the last stages in the preparation of the ova and spermatozoa for conjugation result in halving the number of rods in the original germ-cells. Now, as Hertwig and Weismann point out, one point is still left in doubt. Why is the chromatin substance doubled in the mother-cells so that two successive subdivisions are necessary to reduce it to half the original quantity? Hertwig has not attempted to answer this question, as he prefers to wait for further research. Weismann, however, who is unfortunately cut off from research by failing eyesight, has offered a speculative solution to this problem which he trusts may guide future investigation.

This leads me to say a few words in regard to his conception of the relation of the chromatin to heredity. 1. His first premise is that in fertilization there is not a fusion of chromatin but that a certain independence is preserved between the maternal and paternal elements, based upon the observed fact that the two pairs of rods do not fuse but lie side by side, and upon the assumption that these pairs are kept distinct in each cell through all the subsequent stages of embryonic and adult development. If this be the case, the hereditary substance contributed by the father would remain separate from that contributed by the mother, throughout. 2. "Each of these pairs would be made up of the collective predispositions which are indispensable for the building up of an individual, but each possesses an individual character, for they are not entirely alike. I have called such units "ancestral plasms," and I conceive that they are contained in numbers in the chromatin of the mature germ-cells of living organisms, also that the older nuclear rods are made up of a certain number of these.

. . . Obviously these units cannot become infinitely minute; however small they may be they must always retain a certain size. This follows from the extremely complicated structure which we must without any doubt ascribe to them." These units are not, however, ultimate, they are in turn extremely complex, and are composed of countless biological units of the kind conceived by Nägeli and others. 3. The reduction of the chromatin only acquires a meaning when taken in connection with the above supposition of distinct ancestral plasms, and has no meaning if we accept Hertwig's view that there is a complete fusion of maternal and paternal germ-plasm. This meaning is that reduction in the maturation of germ-cells is *sui generis*, it does not divide the ancestral plasms into two similar groups, but one daughter-cell receives one set of germ-plasms or hereditary predispositions, and another daughter-cell receives another; reduction is thus differential. According to this view the four sperm and ovum daughter-cells would each contain a different set of ancestral plasms. 4. The fact that the chromatin substance is doubled in the sperm and ovum mother-cells, so that we observe double the number of rods characteristic of the species, is to be explained as an adaptation to the requirements of natural selection, for this doubling and subsequent double division render possible an infinite number of combinations (as many, in fact, as there are individuals) for Selection to operate upon.

This explanation of Weismann's is an example of his apotheosis of the theory of natural selection. Every process is made to suit this theory, which, as we have seen in the first and second lectures, is, in his opinion, the exclusive factor of evolution. But this very high degree of mingling and remingling of ancestral predispositions would be fatal to evolution, for after a combination favorable to survival had been established in one generation it would be broken up into a new combination, perhaps unfavorable to survival, in the next generation. This entire essay upon "Amphimixis," or the theory of mingling of reduced hereditary substance, will, I believe, mark a turning-point to decline in Weismann's influence as a biolo-

gist. His whole reasoning is now in a circle around the natural selection theory.

*The Meaning of Conjugation.*—Weismann looks upon sexual reproduction as designed to mingle hereditary tendencies and to create individual differences whereby natural selection may form new species. It is evident that these combinations must be mainly fortuitous and productive of indefinite variation; but we have seen that evolution advances largely by the accumulation of definite variations, or those in which each successive generation exhibits the same tendencies to depart from the typical ancestral form in certain parts of the body, and that these tendencies stand out in relief among the diffused kaleidoscopic or fortuitous anomalies.

The fact, moreover, that variability and evolution by the accumulation of certain variations in successive generations is also observed in organisms which reproduce asexually, both among plants and animals, shows that we must look in another direction for the underlying cause or purpose of sexual reproduction. Weismann rightly combats the old idea of "vitalization" of the ovum by the spermatozoon, and it is perfectly evident from the researches of Maupas and Hertwig that the ovum may as accurately be said to vitalize the spermatazoon as the reverse. Fecundation is simply the approximation of two hereditary substances of distinct origin and their incorporation into a single nucleus. The action and reaction of these substances may be considered equal and mutual so far as we now know.

The remarkably ingenious experiments of Hertwig and Boveri, above alluded to, strengthen this idea. Some years ago Weismann wrote: "If it were possible to introduce the female pronucleus of an egg into another egg of the same species, immediately after the transformation of the nucleus of the latter into the female pronucleus, it is very probable that the two nuclei would conjugate just as if a fertilizing sperm-nucleus had penetrated. If this were so, the direct proof that egg-nucleus and sperm-nucleus are identical would be furnished." Boveri succeeded in accomplishing a similar feat by depriving an ovum of its nucleus and subsequently causing it

to develop by admitting *a spermatozoan which fertilized the denucleated ovum and produced a complete individual!*

In opposing the vitalizing properties of the sperm, Weismann, however, went further, and advocated the view that there is nothing in the nature of vitalization or "rejuvenescence" in conjugation—that, given proper environment, protoplasm is immortal, and runs upon a course of undiminished activity. This we have seen is not the case in the Infusoria, and, as recently remarked by Hartog, there is only one class of organisms which, according to our present knowledge, are completely agamous and immortal—namely, the Monadina. It may in future appear that even in the monads there is a cycle for the development in which conjugation plays its part.

Maupas's experiments seem to establish the primitive, and therefore the true, interpretation of the purpose of conjugation as well as of sex, the latter being a consequence of the former, namely, that after a long period of direct subdivision of hereditary material from a single individual, a limit is reached beyond which the forces of heredity are not reproduced in their original intensity unless combined with another set of similar forces of different origin. This combination restores the original intensity. It is objected to this that two sets of feeble forces cannot constitute one vigorous force, but this is met by the observed fact that such union does start a new life cycle, and is therefore rejuvenescent. We may regard this as the fundamental meaning of conjugation and the production of variations as entirely secondary.

*The Distribution of the Chromatin.*—We have now reviewed some of the main phenomena of fertilization; there still remains the relation of the hereditary substance to the future development of the individual. There is, first, the astonishing fact that, as the chromatin goes on dividing, its mass or volume remains apparently undiminished; that is, there is apparently as much chromatin in one of the many million active cells of the body as in the original fertilized ovum, and there is still an enigma as to the nature of this chromatin and its functions. Secondly, there is the problem of the maternal and

paternal elements in each cell; do they lie side by side or are they fused?

1st. In plants De Vries[8] and others believe that all or by far the greater number of cells in the plant body contain the total hereditary characters of the species in a latent condition. Kölliker[9] has fully discussed this question and called attention to Müller's early views that, in spite of the physiological division of labor producing the tissues, the properties of all the tissues can be derived from the nuclear substance of a single tissue, as proved by experiments upon the lower animals. Weismann, on the other hand, has held that the course of development is marked by a constant qualitative distribution of his germ-plasm or hereditary substance, so that, so far as nuclear content is concerned, there are three forms of cells: 1, with nucleoplasm; 2, with nucleoplasm and germ-plasm; 3, with germ-plasm only. Kölliker opposes this idea and maintains that the "idioplasma" passes into all cells, in which it divides in course of development; step by step from the embryonic layers to the tissues, the constructive processes are under the direction of the nuclei containing this hereditary substance; it remains in every nucleus for a long period unaltered, in order to finally, here earlier, there later, impress its constructive forces. In certain elements, as in blood-corpuscles, epidermal scales, etc., it disappears, as the last product of division.

R. Hertwig takes a similar view; since embryonic and adult cell division is differential there must be a form of differentiation in the nucleus, but this does not consist in the total elimination of some qualities and survival of others, nor of a reduction in mass. The mass and the properties remain the same in every cell, the differentiation consists in the activity of certain elements in certain tissues. Thus we may say with De Vries, that different "pangene" may leave the nucleus and enter the cell in different tissues, or with Nägeli, that special "micellæ" come into activity at certain points; in other words,

[8]Hugo de Vries: Intracellulare Pangenesis. Jena, 1889.

[9]Die Bedeutung der Zellkerne für die Vorgänge der Vererbung, Zeit. f. wiss. Zoöl., 1885. And, Das Karyoplasma und die Vererbung, op. cit., 1886.

the potential of the nucleus is differently exerted. Here, again, we have the idea of patent and latent hereditary elements, such as appear in the entire individual upon a larger scale.

This is one of the most interesting problems for future investigation, but the direction of research will, I imagine, cover a larger area of cell-content than the nucleus, as we are now swinging back to regard the extra nuclear archoplasm as an important factor in the process.

In the following paragraph Hertwig expressed his view of nuclear control and cytoplasmic differentiation:

"As I saw in the transformation of the nucleus during fertilization proof that it is the bearer of hereditary substance I recognized a great advance in the fact that the nucleus leaves in the same form in every cell, and in its vesicular capsule is somewhat removed from the metamorphoses of the cells. As Nägeli spread his idioplasm as a net-work throughout the whole body, so, according to my theory, every body-cell contained in its nucleus its quota of hereditary substance, while its specific histological peculiarities were to be regarded as its plasma-products."

2d. The next question *is the fate of the maternal and paternal contributions to the embryo.* Here there is a wide difference of opinion. On the one side Van Beneden is the leader of those who regard each cell of the body as in a sense hermaphrodite; as we have seen, his views of maturation and the significance of the extension of the polar bodies were colored by this theory, for he regarded the germ-cells as hermaphrodite until one sex was eliminated. But now that the researches of Hertwig have given the last blow to Van Beneden's theory, and it follows that there can be no male and female chromasomes, there still remains room for the analogous view that the maternal and paternal chromasomes remain distinct throughout the course of development, not as sexual elements but as substances with the same racial and specific but different individual tendencies. Rabl, an eminent embryologist, shares this view, and it is supported by Boveri upon the observation that in each division the paternal and maternal elements are kept distinct, and in *Ascaris*, for example, two of the chromasomes

of each division figure are paternal and two are maternal. In favor of this hypothesis we may place the following facts: 1st, that there are an even number of chromasome rods in all cells; 2d, that the number is constant throughout all the subsequent changes in the tissues; 3d, that the number is fixed for each species or variety; 4th, that the number is the same in each sex.

Against this *replacement* hypothesis we must consider the extreme complexity of the division process, and the long-resting, or thread stage, in which the chromatin lies in a confused coil. Further, Hertwig argues that if the elements are distinct we should find some evidence that the maternal or paternal part is atrophied or replaced, or excluded from the nucleus, for both parts cannot share alike in the control of the cell. These are Hertwig's grounds for supporting the "verschmelsungstheorie," or *fusion* theory, also advocated by Waldeyer, to the effect that by the complete union of the maternal and paternal substance a new product is formed; in this fusion the law of prepotency may come into play, causing one or other of the parental tendencies to predominate, or there may be an even redistribution, whereby, as expressed by Hensen, "the hereditary substance of the son is not that of the father plus that of the mother, but is his own, with a new hereditary form resulting from the combination."

While suspending judgment between these two views as to the separation or fusion of the chromatin, we may appeal to the external phenomena of heredity for light upon the probabilities in the question. First, I refer to the very decided opinion of Francis Galton in regard to particulate inheritance; he is so impressed with the fact that we are made up bit by bit of separate structures derived from different ancestors that he has even suggested that the skin of the mulatto may represent not a fusion of white and black but an excessively fine mosaic in which the colors are so distributed as to give the appearance of blending. We do sometimes observe patches of color as evidence of uneven distribution. As Galton distinguishes two types of structures with reference to inheritance, viz., those which blend and those which do not blend, we might corre-

late these types with prepotency, replacement, and fusion. Where characteristics do not blend, as in eye-color, it is evident that, while the offspring must receive from both parents the material basis for the formation of the complete color of the eye, either the maternal or paternal material must be prepotent and exclude the development of the other; the logical inference is that the former actively replaces the latter; but it is not necessary that exclusion from the cell chromatin should follow. Now, while some blends seem to support the theory of fusion, the sum total of facts of heredity are strongly against this as a universal principle, for many maternal and paternal structures are preserved in their absolute integrity for generations without the least indication of mixture.

**Cell Forces and Heredity.**—We have thus far been considering only the chromatin as the heredity substance *par excellence*, and have disregarded for the time the archoplasm or dynamic material of the cell. If we advance upon the hypothesis that a typical cell contains the more or less passive chromatin, and the archoplasm playing upon this chromatin in course of every phase of redistribution, it seems *á priori* improbable that elements which are associated with every vital change should be dissociated in the phenomena of heredity. We might suppose that the mechanics of karyokinesis are exactly similar in every cell of one individual, but it is highly improbable that they should be exactly similar in two individuals. We should, therefore anticipate the joint transmission of the chromatin and archoplasm, implying by the latter the dynamic centers especially connected with hereditary function as distinguished from the general functions of metabolism.

This leads us to look for evidence from the life of the cell in its totality. We owe to Dr. Max Verworn[10] a fresh treatment of this subject, based upon experimental researches among the Infusoria, mainly by the extirpation method. As his experiments included only the phenomena of living cells

[10]Die Physiologische Bedeutung des Zellkerns, Archiv für Physiologie, 1891, pp. 113–115.

in which the chromatin substance was of course undifferentiated to the eye, he treats of the nucleus as a whole without distinction as to chromatin and achromatin. He concludes that the physiological importance of the nucleus is exhibited in its constant interchange of materials with the remainder of the cell body, only through this interchange does it influence the cell and control its life processes. The interchange is in triple currents, *a*, from outside of cell to cytoplasm; *b*, from cytoplasm to nucleus; *c*, from nucleus to cytoplasm. These movements of interchange are the expression of life phenomena. He compares the *rôle* of the nucleus to that of a cell organoid, like chlorophyll, as not constantly present but as invariably necessary to activity. Thus he believes even the most lowly organized cells have nuclear centres, and that even bacteria are differentiated into nuclear and extra-nuclear areas. Coupled with this idea of nuclear control is the somewhat paradoxical statement that the nucleus is not a dynamic centre, either automatic or regulating, and the conclusion that the nucleus alone cannot be the seat of fertilization and heredity, but both the nucleus and extra-nuclear protoplasm must constitute the material basis of heredity. This conclusion is in the direction of the general reaction of opinion which is now taking place against the centralization of cell-government in the nucleus.

Vague as they must necessarily be, our ideas of cell forces are somewhat further defined by the brilliant experiments of the Hertwig brothers upon germ-cell physiology and pathology, which are full of suggestion as to the causation of abnormalities in inheritance. These were begun in 1884 and were first directed to the influence of gravitation upon the planes of embryonic cell division, following up the experiments of Pflüger and Rauber. In 1885 the conditions of bastard fertilization were studied; in 1887 the causes of polyspermy or multiple fertilization; and in 1890 the effects of extreme heat and cold upon germ-cell functions.[11] In general the conclusions reached were that in the normal state there exist regulating

[11] Experimentelle Untersuchungen über die Bedingungen der Bastardbefruchtung, Jena, 1885. See series of papers in Jenaische Zeitschrift.

forces in the ovum which prevent multiple fertilization or bastard fertilization (*i. e.*, by spermatozoa of other varieties), but these forces are neutralized where the life-energy of the cell is diminished by reagents or by extremes of temperature.

For example, in the normal state the entrance of a single spermatozoon produces a reaction in the ovum-wall preventing the entrance of other spermatozoa, but when the ovum is weakened by chloroform solution two or more spermatozoa enter before the reaction appears; in fact the degree of polyspermy is directly proportional to the intensity of the chemical, thermic, or mechanical disturbance of the ovum. Double fertilization or over-fertilization has not in a single case resulted in the production of twins, so that Fol's supposition is negatived, although other forms may behave differently. The cell-function may be arrested at any stage by thermic influences; thus two pronuclei, paternal and maternal, about to unite can be held apart by lowering the temperature. Polyspermy also results from a lower temperature. It is noteworthy that the conditions of bastard fertilization and polyspermy are different; chloroform produces the latter but not the former. Kupffer has, I believe, succeeded in producing twins, or rather two-headed monsters, by abnormal fertilization in fishes.

These researches, although made with a different object, re-establish the older views as to the interdependence of nuclear and extra nuclear activities, and show that no sharp line of demarcation of function can be drawn between the nucleus as a center of reproduction and heredity, and the cytoplasm as the seat of tissue-building and nutrition. In Boveri's discovery of the archoplasmic centres, or centrosomes, we find positive ground for this broader view. It is connected with the cell phenomena of heredity in the following manner:

While the union of the nuclei in fertilization is the most obvious feature, this union is dependent upon the archoplasm, which rearranges the nuclear elements. If the spermatozoon contains no archoplasm, this power cannot come from the paternal side; but Boveri shows that this is probably not the case and that the spermatozoon brings its centrosome with it, thus entering the ovum with both the paternal chromatin sub-

stance and dynamic material. It is certain from this and from the observations of Roux that the sperm-cell is now to be regarded as more than a mere nucleus, that it contains both nuclein and para-nuclein.

*Intercellular Forces.*—The forces within the different portions of the cell lead us to consider those which must exist between different cells. This is an obscure question at present; but, as I have observed in the close of the second lecture, it is an extremely important one in connection with the problem of heredity. As Professor Wilson writes, "My own conviction steadily grows that the cell is not a self-regulating mechanism in itself, that no cell is isolated, and that Weismann's fundamental proposition is false."

It is a long step between an *á priori* conviction and the demonstration by experiment of a correlation of forces between the cells. This seems to me a most important field of experiment. We have seen in Maupas's work that the contact of two Infusoria initiates a rapid series of internal changes; we have only to conceive of analogous changes taking place when two cells are not in actual contact, as in the phenomena of previous fertilization referred to in my second lecture. Hertwig and others have shown how gravitation is related to cell activity. Roux has destroyed half an embryo with a hot needle in the first stages of segmentation and followed the other half through the stages of subsequent development. Another clever experimenter has turned fertilized ova upside down during the early stages of development, and shown how the protoplasmic pole and yolk-pole forcibly change places. Driesch has traced the connection and meaning of the first plane of cleavage in the embryos of echinoderms, and has succeeded in raising a small adult from half an embryo artificially separated during the first cleavage stage. Wilson, in the larva of Nereis, has shown how a certain stage of division in one group of cells affects all the other groups. All these experiments are in the line of determining the relation which exists between internal cell forces and other natural forces. What we must now seek to determine is the relation of cell to cell throughout the body, in connection with the phenomena of heredity.

**Conclusions.**—The most impressive truth issuing from our review of recent researches in evolution and heredity is the uniformity of life-processes throughout the whole scale of life from the Infusoria to man. The most striking analogy is that seen in the laws of fertilization and conjugation, which are shown by Maupas's researches to have been established substantially in their present form at a very early period in the evolution of living organisms. Such uniformity furnishes a powerful argument for the advocates of the study of biology as an introduction to the applied science of medicine. Much that is now entirely omitted from medical education, because it is considered too remote, is in reality at the very roots of the science. To understand the disorders of life we should first thoroughly understand the essential phenomena of normal life. Of course we shall never see life as it really is, because there is always something beyond our highest magnifying powers; but we come nearest to this invisible form of energy when, with such investigators as Hertwig and Maupas, we strip the life-processes of all their accessories and view them in their simplest external form.

The problems of evolution are found to be inseparably connected with those of heredity. No theory is at all adequate which does not explain both classes of facts, and we have seen that the explanations offered by the two opposed schools—those who believe in the transmission of acquired characters and those who do not—are directly exclusive of each other. We should suspend judgment entirely rather than cease to gather from every quarter facts which bear upon the most important and central problem of the transmission of acquired characters. I have endeavored to point out the opportunities which medical practitioners enjoy of contributing evidence upon this mooted question. It must not be forgotten that while the inheritance of individual adaptation to environment is the simplest method of explaining race adaptation such as we observe in the evolution of man, we know absolutely nothing of how such inheritance can be effected through the germ-cells. We cannot at present construct even any form of working hypothesis for such a process. On the other hand, we

have found how untenable is the alternative theory offered to us by Weismann, that it is solely natural selection or the survival of the fittest which

> ". . . shapes our ends,
> Rough-hew them as we will."

At the same time Weismann's conception of a continuity of germinal protoplasm, which we have found to consist in chromatin plus archoplasm, helps us over many of the phenomena of heredity, especially on the retrogressive side, and if it were not that we must also account for progressive and definite transformation in heredity, we might credit the distinguished Freiburg naturalist with having loosed the Gordian knot.

In summing up, the order of treatment followed in the lectures may be reversed, and we can begin with the germ-cells, and condense the more or less ascertained facts.

*The Germ-cells.*—1. The material substance of hereditary transmission is the highly coloring protoplasm, or chromatin, in the nucleus of the germ-cells, probably connected with a certain form of archoplasm, or dynamic protoplasm, outside of the nucleus.

2. Before conjugation and fertilization the hereditary substance of both the male and female cells is reduced to one-half that found in a typical cell. The substance is, however, first doubled and then quartered, the meaning of which process is not understood.

3. There is a difference of opinion as to whether the paternal and maternal hereditary substances, are fused or lie side by side during fertilization, also as to how the substance is distributed through the tissues, during individual growth, whether *en masse* or by qualitative distribution.

*Heredity.*—4. No form of physical connection between the germ-cells and body-cells is known, but the facts of heredity seem to render such a connection theoretically necessary. Several classes of facts witnessed in reproduction seem to support this theory.

5. The facts of Heredity support the theory of a continuous and specific form of protoplasm as the basis of repetition of type.

*Evolution.*—6. The facts of evolution, both in present and past time, point to transformism by definite progression toward new types of structure in succeeding generations, opposing the retrogressive forces of heredity.

7. The theory (Natural Selection) of definite progression by the accumulation of fortuitous favorable variations is found to be not only theoretically improbable, but not to correspond with the observed laws of variation.

8. The laws of variation (anomalies) lend support to the theory of hereditary transmission of individual acquired variations, but even this (Lamarckian) theory encounters many difficulties.

I think this is as fair a statement as can be made at the present time, and it rests upon a general survey of the whole field.

# THE HEAD OF AN EMBRYO AMPHIUMA.

By J. S. Kingsley.

The following is a preliminary account of some studies of a single stage of *Amphiuma means* before hatching. For the material I am under great obligations to Prof. O. P. Hay, of Irvington, Indiana. I must also return my thanks to Prof. Dr. Robert Wiedersheim, in whose private laboratory in the University of Freiburg i-B., my studies were conducted. Only one who has enjoyed the privilege of working with him can appreciate his many kindnesses and extreme helpfulness.

External appearance.—The general appearance of the eggs has already been described by Dr. Hay, and is strikingly similar to that of Ichthyophis as described and illustrated by the cousins Sarasin. This resemblance is strengthened by the fact that the cord connecting the eggs is spirally twisted as in the Ceylonese Gymnophione described by them.

The external description of the embryo Amphiuma has been correctly described by Hay in most points, but in a few respects my specimens differ from his description. According to him "the gills consist of three pairs, and are of the simply pinnate form. . . Only once have I observed any of these lateral filaments to divide. . . Three gill slits are still open." The figures which illustrate this are strikingly like those of the Sarasins of the branchiæ of the Ichthyophis larvæ. In the larvæ which I studied the resemblance is not so striking. The three gills of either side are united at the base into a common trunk, the gill filaments are not bipinnately but irregularly arranged, and in none of my specimens have I found more than one gill cleft open. (*Cf. infra.*)

Chondrocranium.—The cartilaginous skull, as it appears in a wax reconstruction after Born's method (and compared with dissections), is more slender than in Hay's figures; it also presents minor differences in several other respects from his rep-

resentation and description, to which reference should be made in reading the following account:

In front of the pituitary space the trabeculæ unite into a broad horizontal plate, the line of junction of the two halves being entirely obsolete, while still farther forward the cornua trabeculæ, instead of being two-lobed, form a broad triangular plate. Between the two cornua is a deep and narrow notch with parallel sides in which is imbedded the septum osseum of the premaxilla to be described below. The trabeculæ, on either side of the pituitary space, are high and compressed. Just behind the nasal capsules two processes are given off on either side. The upper one, arising from the trabecular crest is, as Hay calls it, the rudimentary nasal capsule, and in one specimen upon one side I found a perforation in this process which suggests the more extensive fenestration in the nasal cartilage of the adult Necturus and Protopterus. The lower process may retain the name, antorbital, usually applied to it, for Amphiuma presents no evidence that it is the palatine cartilage as Gaupp interprets it.

Somewhat farther behind these processes than in Hay's figure are two openings through the trabeculæ for the passage of the optic and oculomotorius[1] nerves.

The trabeculæ are united to the posterior portion of the cartilaginous skull by three processes. The upper connects the crista trabeculæ with the ear capsule; the middle, the process ascendens of Stöhr and other authors, goes from the trabeculæ to the inner anterior angle of the quadrate; the third, the radix trabeculæ, is bifurcate posteriorly, the outer ramus joining the floor of the otic capsule, the other uniting with the parachordal floor of the cranial cavity.

The parachordal cartilage lies beneath the notochord, as do the lower arcs of the occipital and first cervical vertebræ. Between the parachordals and the otic capsule on either side is a large oval opening in the cranial floor. The occipital vertebra is confluent below with the parachordal cartilage; on

[1]Hay suspected that the posterior of these foramina was for the transmission of the third nerve. I have traced the nerve from its origin, through the opening, into the proper eye muscles.

either side it merges with the posterior angle of the otic capsules; above it is incomplete. Between the ventral portion of the occipital vertebræ and its lateral union with the otic capsule is the foramen for the vagus nerve.

The otic capsules are elongate oval. In front they project slightly beyond the point of union with the cristæ trabecularum, behind they merge into the occipital vertebra. In the lower outer surface is the large oval foramen ovale, and just in front of it is the external opening of the foramen for the facialis. This foramen does not penetrate the ear capsule proper, it only passes through its anterior wall. On the inner lower surface the otic capsule is produced into a narrow ledge which projects inwards to form a part of the floor of the cranial cavity, being limited internally by the large opening between it and the parachordal cartilage. The inner wall of the capsule is perforated by three subequal openings in the same plane, and a fourth smaller one above them and between the two posterior ones. The anterior of these forms a considerable cavity, in which is situated the acustico-facialis ganglion and from it nerves go through the adjacent cartilage in the following directions: One branch, the ramus palatinus, goes ventrally through the floor; a second, the facialis proper, goes straight outward to reappear, as just mentioned, upon the outer surface; while the third, the ramus vestibularis of the eighth nerve, goes upward and backward to the sensory epithelium of the inner ear. Separated by a considerable cartilaginous interval from the first of these openings is a second, nearly equal in size, through which the ramus cochlearis of the auditory nerve enters the ear; the small upper opening permits the ductus endolymphaticus to pass above the brain in the same manner that the ductus perilymphaticus goes through the fourth opening beneath the brain. I have seen no special opening in the cartilage for the passage of blood-vessels to the inner ear.

Cartilaginous Visceral Skeleton.—The quadrate is rhomboidal in outline when viewed from the side, the external surface exhibiting a slight depression. As yet it is connected with the skull by only the process ascendens, the processes

oticus and palatobasale being as yet undeveloped. Behind, from the posterior angle, is a projection with which articulates the cylindrical process opercularis (columella), the posterior end of which is imbedded in the still membranous opercular membrane (stapes of Hay), which closes the foramen ovale. Meckel's cartilage articulates with the lower angle of the quadrate, a process extending behind the articulation, for the insertion of the digastric muscle. The two halves of the lower jaw are united by fibrous connective tissue in front. I find no trace of Hay's pterygoid cartilage. The hyoid and branchial arches call for no remark aside from the fact that they lack the yoke which binds together the upper ends of the branchial bars in Amblystoma embryos, and, according to Stöhr, in some other forms.

Ossifications.—These have been well described by Hay and only a few words are necessary. The ossifications are here, as Weidersheim has pointed out for all urodeles, perichondrostoses. They consist of, in the cranium at this stage, premaxillary, vomeropalatines (better dermopalatines), parasphenoid, frontals, parietals, squamosals or tympanics, occipital and small patches surrounding the exits of the vagus nerves. In the lower jaw dentary and angular bones are seen, while ossification occurs on the hyoids. The premaxillary at this comparatively early stage shows no trace of a double origin, either in front or in that median osseous process extending backwards, which separates the two nasal cavities. This is the septum osseum of Weidersheim, and is clearly a portion of the premaxillary. It is also, I think, the same bone which Cope has called ethmoid, and upon which both he and the Sarasins have placed great weight in their association of the Gymnophiona with the Amphiumidæ. The squamosal of Amphiuma is clearly not homologous with that bone which Weidersheim (and following him Cope) has called by that name in the Cæcilians, but to which the Sarasins have applied the name jugal. The ossification of the occipital region is peculiar. As is well known the occipital region of the urodele skull is formed by the junction of a primitively separate vertebra with the parachordals and otic capsules. In this vertebra, above its carti-

laginous lower arch and in the fibrous connective tissue on either side of the notochord is a deposit of bone of such a character as to suggest the existence here of an earlier vertebral centre which has disappeared.

Visceral Clefts.—My specimens are too old to throw any light upon the mooted question of an obsolete visceral segment between mandible and hyoid, but in the region behind the last branchial cleft of the ordinary Amphibian some interesting facts are seen. A reconstruction of the floor of the throat after the method of Born shows the following clefts distinctly: —*a*, the hyomandibular or spiracular cleft, which like *b* and *c*, the first and second branchials, is not open to the exterior; *d*, the third branchial cleft which is still functional, opening to the outer world as already described in referring to the external appearance. Behind this last cleft comes the fourth cartilaginous gill arch; and still behind this and between it and the trachea are two other pits, clearly serially homologous with the others, and hence to be regarded as the representatives of the two posterior clefts of the typical elasmobranchs and ganoids. Of these the anterior (fourth branchial) has already been recognized as occurring in the Amphibian ontogeny; it is the "Suprapericardialkörper" of authors, which Maurer has shown to be the fourth gill cleft. The posterior, the fifth gill cleft has not before been recognized in the Batrachia. These posterior clefts bear such relationships to the trachea as to lend countenance to that view which would derive lungs and trachea from modified gill slits. Should this view ever be substantiated, it may be that the laryngeal cartilages will be shown to be the modified gill-bars of this region. Amphiuma, however, throws not the slightest light directly upon the phylogeny of these structures.

In this connection I may state that in the early Siredon stage of *Amblystoma jeffersonianum* the posterior (fourth) branchial cartilage is bifid at its upper and posterior extremity[2] in such a manner as to suggest that there was formerly here an additional arch, the traces of which are disappearing in the same way in which the posterior gill of Ichthyophis is

[2]This, of course, bears no relationship to the bifid ceratohyals of the ganoids.

merged with its predecessor. In Amphiuma I find no trace of any gill bar behind the fourth of the adult.

Nervous System.—The brain of the larva studied varies considerably from that of the adult as described by Osborn. The account of the internal structure is reserved until later. Externally it is characterized by its shortness and longitudinal compression, this being more marked than in any adult Batrachian except that of the Gymnophiona as described by Waldschmidt and Burckhardt. It exceeds in this respect the brain of Protopterus as figured by Fulliquet. As in the latter form the cerebral hemispheres are pushed back upon and wedged apart by the twixt brain, while behind, the mid-brain and cerebellum are so folded over upon the medulla that the lateral angles of the 'fossa rhomboidalis' extend nearly to the posterior lobes of the cerebrum.[3] The brain flexure, however, is apparently slight, the primary bend being corrected by a secondary one. The cerebral hemispheres are distinct above and in front of the lamina terminalis; the olfactory lobes are not distinct from the hemispheres. The floor of the twixt brain is very short and the infundibulum and hypophysis are very broad, the latter being wider than the mid-brain in its widest place. The choroid plexus of the anterior ventricles is well developed, but calls for no special remark. The cavity of the pinealis is still in connection with the cavity of the brain and its enlarged distal portion, which reaches nearly to the roof of the cranial cavity, is considerably lobed and folded.

The olfactory nerve arises by a single root,[4] goes laterally from the tip of the hemisphere and, in the nasal capsule, divides into upper and lower branches which innervate the nasal epithelium and Jacobson's organ respectively.

The optic and oculomotor nerves call for no comment. I failed to find the fourth (trochlearis) and the sixth (abducens) in my preparations.

The fifth nerve presents several features of interest. As my

[3]Cf. Waldschmidt's account of the Gymnophionan brain.

[4]Weidersheim formerly thought that the double origin of the olfactory in the Gymnophiona had great morphological importance, but the studies of the Sarasins and of Burckhardt show that such is not the case.

material was none too well preserved, I am not able to say how many roots the nerve has, as it comes from the brain. Several distinct groups of fibres go from the anterior angle of the medulla to the gasserian ganglion. This latter structure is single and shows none of the double character described by von Plessin and Rabinowicz[5] in *Salamandra maculata*. Nor do my studies of the nerve fibres agree with their accounts of the nerves. The Gasserian ganglion is oval in shape. It lies in the angle formed by the otic capsule, the processes of the trabeculæ and the process ascendens of the quadrate. From its hinder surface a commissure connects it with the ganglion acustico-facialis. From its outer surface arises the maxillaris inferior, and from its anterior end, at different levels, the rami ophthalmicus superficialis, ophthalmicus profundus and maxillaris superior. The maxillaris inferior and the maxillaris superior, after leaving the ganglion, pass from the cranial cavity between the process ascendens of the quadrate and the otic capsule. According to von Plessin and Rabinowicz these rami are different in cerebral origin in *Sal. maculata*, but in my section some of the fibres which compose each are easily traced to a common origin. Of the distribution of these nerves nothing need here be said.

The two ophthalmici leave the cranial cavity through the foramen below the process ascendens of the quadrate. The ophthalmicus profundus passes beneath the optic and oculomotorius and breaks up into fibres at the posterior wall of the nasal capsule. Fibres from the ganglion of the seventh are traced through the gasserian ganglion into the ophthalmicus superficialis.

The compound facialis-auditory ganglion is long and narrow. From it arises the palatine branch which goes through

[5]According to these authors the Gasserian ganglion consists of two distinct and separate ganglia: a ventral principal ganglion and a more dorsal accessory portion. The chief ganglion has its proper medullary root, while the root of the accessory ganglion is close by and a little dorsal to the root of the acustico-facialis. From the principal ganglion arise two nerves, called respectively mandibularis (= maxillaris inferior) and nasalis (= ophthalmicus profundus); from the accessory ganglion arise the supramaxillaris superior (= maxillaris superior) and the frontalis (= ophthalmicus superficialis).

the floor of the otic capsule to be distributed as usual. The facialis branch divides into two portions just outside the cranial wall and behind and below the quadrate; the very large posterior branch runs backward to innervate the posterior belly of the digastric muscle. The anterior ramus has the usual distribution.

An especially noticeable feature in connection with the twelfth nerve is the persistence of the dorsal ganglion. Waldschmidt's observations on Protopterus and those of von Plessin and Rabinowicz upon Salamandra are interesting in this connection.

The nasal organ has a well developed organ of Jacobson, though on a simpler type than that of the Cæcilians. The sensory epithelium of the nose, is in these embryos, not differentiated as in the adult.

Conclusions.—Following such students of the Batrachia as Cope and the Sarasins it is with some diffidence that I dissent from their conclusions, for both regard Amphiuma as a connecting link between the Cæcilians and the Urodeles. That both Gymnophiona and Amphiuma are degenerate goes without question, but it seems to me that their many peculiar resemblances are those of homoplassy rather than derivations from a common ancestor. Then again, some of these resemblances have been founded upon mistakes. Thus the possession of an ethmoid by Amphiuma cannot be maintained. The external gills of the larvæ are not so similar as has been supposed; the derotrematous condition which appears later has one important difference: In Amphiuma only the third gill slit persists to open through the round external opening to the exterior, and my material shows that when the other slits were open they had separate openings upon the side of the neck. In Ichthyophis, on the other hand, the observations of the Sarasins show that both the second and third slits have a common external opening.

On the other hand, there are certain differences to be emphasized. The presence of an ethmoid in the Gymnophiona (and its absence from Amphiuma and other Urodeles[6]) the exist-

[6]The ethmoid of H. H. Wilder in Siren is clearly not homologous with the bone (mesethmoid) called by that name in other vertebrates. It is rather the prefrontal of authors.

ence of a turbinal, the absence of a parasphenoid and the presence of a basisphenoid are all points of importance, as is also the frequent presence of two rows of teeth. Again, in the Cæcilians we find a multiplicity of bones such as occurs in the lower Ichthyopsida but not in the Urodeles, and which consequently cannot be derived from the latter. Regarding the chondrocranium of the Gymnophiona no comparison can be made until the appearance of the promised paper by Burckhardt.

The view is quite common that the origin of the Batrachia (sens. lat.) must be sought in the Dipnoi. Thus Cope says (Am. Nat., xviii, p. 725–6, 1884): "The Batrachia have originated from the sub-class of fishes, the Dipnoi, though not from any known form."

This view had doubtless its foundation in the existence of both gills and lungs in these forms. As yet, however, no careful study of the distribution of the cranial nerves and of the ontogeny of the chondrocranium of any Dipnoan has been published, and until we have more detailed accounts than have as yet been made it is safe to assume that the resemblances which have been pointed out between the Dipnoi and the Urodeles are those derived from a common ancestry. Of these resemblances probably the most important is that of the relation of the mandibular arch to the skull. Thus Huxley has divided the Ichthyopsida into autostylic, hypostylic and amphistylic groups, and has shown the close resemblances of the Amphibia to the Dipnoi, Chimæroids and Marsipobranchs in the ampistylic character of this connection of the quadrate with the cranium. It is, however, to be noticed that in the Urodeles the pterygoid cartilage never has that close relation to the cranium that this thesis demands, while the autostylic condition arises comparatively late in development, and never attains that completeness which a Dipnoan ancestry would imply.

In short, I would prefer to trace the origin of both Dipnoi and Urodeles from a crossopterygian ganoid ancestry, the former being the apex of their line of development, the latter tracing their descent through the Stegocephali.

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# IMPORTANCE OF THE SCIENCE AND OF THE DEPARTMENT OF PREHISTORIC ANTHROPOLOGY.

By Thomas Wilson.

Prehistoric Anthropology is a new science. During the past eighteen hundred years the Christian, and consequently the civilized world, has, until the beginning of the nineteenth century, lived on in the belief that man's appearance upon earth dated no more than 4,000 years before the commencement of our era, and it was without knowledge of the prehistoric man, nor did it have a suspicion of his existence.

The wise men of Denmark in the early part of the nineteenth century, while studying the characters engraved on their runic stones and the legends in their sagas, discovered evidences of a human occupation of their country earlier than any of which they had heretofore known or suspected. This occurred about 1806, and in 1836 Mr. Thompson, the renowned Danish archæologist (who founded and for fifty years directed the prehistoric museums at Copenhagen), published his first memoir in regard to prehistoric civilizations, which he named after the material principally employed for cutting implements, "The Ages of Stone, Bronze and Iron." These divisions have ever since been universally accepted.

In 1854 Dr. Ferdinand Keller recognized at Meilen, on Lake Zürich, Switzerland, certain evidences which developed into our present knowledge of the Swiss Lake Dwellers, although it has since been proved that lake-dwellings existed in many other countries in Europe.

Beginning with 1841 M. Boucher de Perthes, residing at Abbeville on the river Somme, discovered certain flint implements rudely chipped in the shape of an almond or peach stone with the cutting-edge at the point. He had found them deep in the gravelly terraces of the river Somme, and in such position and association as to force the conclusion that they

were the handiwork of man and of an antiquity before unsuspected. He continued his labor, gaining converts with indifferent success, until the year 1859, when, by agreement, a committee of fifteen gentlemen, supposed to be the best qualified for the task, and in their departments certainly the most learned men of France and England, met on the ground to make personal investigations. After discussion, dispute, and difference of opinion, of which I need not speak here, it was finally decided that M. Boucher de Perthes was correct in his theory, and that these implements were the work of men and of an antiquity heretofore unknown.

Here was born the new science of Prehistoric Anthropology, and since then it has not only become recognized as a science, but whenever and wherever studied and understood it has increased in dignity and importance.

I said a few lines back that the civilized world had, until the beginning of the nineteenth century, lived without knowledge of the prehistoric man and without even a suspicion of his existence. This is more true in Europe than in America. The knowledge of prehistoric man began on this continent several hundred years before it did in Europe. Columbus formed his acquaintance on the discovery of America. The white men on arriving beheld the prehistoric man face to face, and had ample opportunities for knowing, studying him, and finding out everything that was discoverable from contact with him. Though many books have been written about the prehistoric man of America, and their authors have described him as they saw him, yet we know but little of his true nature. The scientific study of this subject has begun only of late years, and we are still ignorant concerning his history or life prior to the discovery of America in 1492; whence he came, to what race he belonged, or what were his habits, customs or monuments. We are even wanting in knowledge of those things peculiar to him since that time, and which have been manifested to us in every period of our contact with him. The study of his language, socialogy, religion, mythology, has just commenced. Many men have written descriptions of their visits to the Red Man of North America, have given his-

tories of their travels, and have written entertaining books on the subject; but these have largely been fugitive, isolated and without connection with any other than the tribe visited, the voyage described, or the travel undertaken. Nor was there any connection proposed between these writers who might have taken up the same line of investigations with other tribes or other parts of the country. I would not dwarf or belittle the labors or discoveries of our pioneers, but conceding for them all that their friends can claim, they have done but little towards giving an accurate anthropological and ethnological history of the North American Indians. As to their history in prehistoric times, before Columbus, no attempt was made by these historians. Collections have been made of the implements of the North American Indian, and large prehistoric museums established in nearly all parts of the United States, beginning back a hundred years or more, which are and will be of great interest and value in writing such a history. But in the majority of these cases the work has been that of collectors, sometimes for commerce, but more often to gratify that thirst for things of antiquity which seems to be second nature of mankind. A study of anthropology will scarcely be claimed by any one as the motive on which these collections were based. So, while we have had an earlier knowledge in America of prehistoric man, yet it has not attained to that dignity and importance as a science as it has in Europe.

The Smithsonian Institution, National Museum, Bureau of Ethnology, Peabody Museum, and several other institutions whose names will occur to the reader, are exceptions to this statement. The number of private persons who are giving serious attention to this science and are doing faithful and valuable work in this connection are increasing every year. My remarks have not been intended as any reflection upon them or as criticisms of their methods, but are aimed at that great body of persons who, interested or pretending to be interested in the study of anthropology, are naught but collectors of Indian relics, who gauge the value of their specimens, if not solely from a monetary point of view, from their number, beauty, and rarity. They do not count their collections as

of value to the sciences or as an aid in solving the great problem of prehistoric man, but regard them as so many trinkets to gratify their own pride or excite the envy of their less fortunate neighbors.

I have considered as part of my duty the endeavor to awaken and elevate the public mind to the importance of the science of prehistoric anthropology, to so far as possible prevent the search for Indian relics as a matter of commerce, and cause collectors to regard these objects in their true light as aids to science, not as gewgaws and trinkets.

In the performance of this duty I have, during the past year, delivered ten public lectures, distributed from my office a thousand or more copies of Circular 47, descriptive of the prehistoric exhibit at the Cincinnati Exposition that has a bearing in this direction, and my Handbook of Prehistoric Anthropology, No. 743, which, it is to be hoped, will not be without effect.

There has also been prepared a circular (No. 49) relating to prehistoric anthropology and containing information for the guidance of explorers and collectors.

Despite the fact that the discovery of prehistoric man in Europe was made so many years, possibly so many hundreds of years, after his discovery in America, yet I am compelled by the facts to declare that Europeans, because of their interest in the new science, have established prehistoric anthropology on a much broader basis and a firmer foundation, and have given to it more thorough and scientific treatment than has been done in the United States. If I make a comparison in this regard between the two countries as to the detriment of our own it will only be that we may benefit thereby, may take warning and so redouble and direct our efforts, using the opportunity and material which we have in such improved methods and increased endeavors that in future years the difference will not be to our disadvantage. If the following statements will direct the attention and increase the energy of our scientists to proper exertion in this regard I shall feel amply repaid for my labor.

Our acquaintance with the aborigines of this country began with Columbus in 1492, but the real history and our first actual knowledge of them began no earlier than 1600, probably 1604 or 1608, now only 280 years since. Americans, therefore, of the present day, are only removed from the prehistoric man of the whole country by that period, nor is it even so long, for this was the commencement of our knowledge. The authors at that time saw him face to face, were able to describe, and wrote their histories of him. He has continued with us ever since, and we have from that time to the present had full and ample opportunity to increase our informatien concerning him by investigation, examination and personal contact.

In France and England, in fact over Western Europe, the period when the last possible contact with prehistoric man could have taken place, the time when all our knowledge concerning him acquired from observation ended with the invasion of Cæsar. So that while the American has not to go back farther than 280 years to study the prehistoric man of his country, and has had him present ever since, the Englishman and Frenchman has to go back nigh 2,000 years; and their opportunities of personal contact ended then if it had not before. It is not at all certain that the Gaul and Briton of that epoch is the real prehistoric man. He may have been related to him, possibly his descendant, but it appears that the prehistoric bronze age had practically ended in that country, and the iron age begun from four to nine hundred years before the advent of Cæsar.

I have said this much to show the difference in the respective opportunities for the study of prehistoric man between Europeans and Americans.

The territory of France is about 200,000 square miles; that of the United States is about 3,600,000, eighteen times larger than France. Mile for mile and acre for acre, the United States will yield as much to the student of prehistoric archæology as will that of France, yet with this difference in area of equal fruitfulness, the United States government is far behind that of France in its interest and assistance given to this science.

Compare the National Museum of France, to wit, that of St. Germain, with my department of the National Museum of the United States. The St. Germain Museum is installed at St. Germain-en-Laye, a few miles out of Paris, in the palace of that name, built by Francis I. I have not the exact dimensions, but it is in the form of a triangle. The front or shortest leg is, I should say, 400 feet long. It is given up entirely to the officers of the institution, and the chambers are living apartments of the officers. The other leg of the right angle has been fire-proofed throughout and completely restored, and it now consists of exhibition halls. This restoration is being continued upon the other wing. The work began in 1879 and is not yet completed. The building is four stories high, and there are now twenty-five halls filled with prehistoric objects open to the public. One entire story is devoted to each the paleolithic and neolithic periods of the stone age, and one to the bronze age, while the basement contains the heavy stone principally architectural monuments of the Roman occupation. Except in the latter, the display made, the objects shown, the epochs, periods, or ages represented, are the same as those now crowded into my one hall. With all her wealth of antiquity, with all the extent of territory, eighteen times greater that of France, the United States devotes to the objects and implements of her prehistoric races less than one-eighteenth part of the museum space occupied by France.

In the management and direction of this museum and of the matters pertaining to this new science there exists about the same difference. The Director of the Museum of St. Germain is a member of the Institute, and approximates in the dignity and importance of his position, to that of the Secretary of the Smithsonian Institution and Director of our entire National Museum. The work belonging to our Bureau of Ethnology is in France committed into the hands of a commission of savants, to which M. Henry Martin, the great French historian, was and M. Gabriel de Mortillet, Depute is the chief.

I shall not attempt to compare the work of this commission with its representative in the United States, but I may indi-

cate the difference when I say that the monuments belonging to the prehistoric age which are attached to the soil and part of the real estate, which have been purchased, restored and are now owned by the Government of France are to be numbered by the hundred.

The Department of Prehistoric Anthropology in the British Museum has for its curator a person, eminent in the ranks of the science, who receives a salary of fifteen hundred pounds per annum, equal to $7,500, a greater sum than is expended in any one year for my entire department. $6,000 are set aside yearly for purchase of specimens.

The Museum of the Irish Academy of Dublin possesses a greater value in prehistoric gold ornaments alone than it has cost the United States for our entire Museum with all its specimens, service, management and furniture.

The Prehistoric Museum of Antiquities at Edinburgh, Scotland, is also extensive. It is devoted exclusively to the antiquities of its own country and forms a complete museum of itself. It has for curator and staff, Prof. Anderson; Dr. Arthur Mitchell and Mr. Black, names that stand as high in their science as do any others of their country in any science.

The Prehistoric Museum at Copenhagen is so extensive and rich that it might be classed as one of the wonders of the world. It occupies the entire Prinsens Palais, has eight exhibition halls, with a full corps of professors, curators, etc., who occupy the highest ranks in science. The riches of this museum are almost beyond computation; 10,000 polished stone hatchets and axes, the contents of eleven workshops, one of which alone furnished 200 hatchets, 58 perforators, 4,000 scrapers, 1,426 arrow-heads, *trenchant transversal.* Fifty-one cases of bronze implements and ornaments, gold objects so numerous and valuable that kept, of course, during the day under lock and key, they are taken out each night and stored for safety in an immense steel safe.

Stockholm has a National Museum devoted entirely to prehistorics, for which the government has organized a bureau and erected a fine museum building, with Messrs. M. Hilderbrand as curator and M. Montelieus as assistant.

The University of Lund devotes the basement story to its prehistoric museum, with Prof. Soderberg for its professor and lecturer.

The University of Upsala, one of the finest and oldest in all Europe, is engaged in the same direction.

The University at Christiana, Norway, has the same kind of arrangement. Rygh and Undset are its professors. An idea can be had of the importance with which this prehistoric science is viewed in this country when I say that while the Numismatic Museum at Christiana possesses a finer collection of United States coins and medals than does our National Museum, yet their desire to keep their own antiquities is so great that they refuse to exchange them for those of any foreign country.

The mention of these Scandinavian museums with the names of some of their professors will give but a faint idea of the dignity which has been accorded to the science of prehistoric anthropology in these countries, and the attention which it has there received. These countries are entitled to the priority of discovery of prehistoric man, and they have maintained a leading place in the science. So much so that he who was its acknowledged head in Europe and the world, Worsaae, was taken into the King's Cabinet and served the latter years of his life as Minister of Public Instruction.

I need not mention the great prehistoric museums of Germany. That at Berlin with Virchow, probably the leading anthropologist of the world, at its head, Dr. Johanas Ranke at Munich, and so they are dotted over the country in every city from the Baltic to the Alps.

Much might be expected from Switzerland, for it is the land of the prehistoric lake dwellers, and she has not disappointed our expectations. Bern, the capital, has no less than three governmental prehistoric museums; one belonging to the Republic was purchased by it lately from Dr. Gross, of Neuveville, for the sum of 60,000 francs. The canton and the city each own a museum of no mean extent, where are gathered and displayed all objects found in the neighborhood. The other cities and cantons of Switzerland are equally alive to

the importance of this science, and equally active in its study and pursuit. Geneva, with Dr. Gosse at its head, Lausanne, with Morel-Fatio, Yverdon, Neuchatel, Bienville, Steen, Constance, Zürich, all are active, energetic and industrious in gathering the objects in their vicinity, in enlarging their museums, in instructing the people, and in the general increase and diffusion of knowledge concerning their prehistoric ancestors and people.

The same story may be said with regard to Italy. Genoa, Pisa, Turin, Milan, Verona, Vicenza, Parma, Regio, Bologna, Imola, Marzabotta, Florence, Arretzo, Cortona, Perugia, Chiusi, Corneto, all possess extensive museums, and so down to Rome, where are to be found three or four great governmental establishments organized with presidents and professors, and approaching the dignity of institutes and colleges with museums attached, all devoted to the study of antiquities almost, if not quite, prehistoric.

This list might be extended indefinitely. Austria, Hungary, Pologna, Russia, are all interested in this new science and are devoting themselves to the spread of its knowledge and to the increase of their museums.

I have failed largely in the purpose if before this time I have not convinced the reader that the United States, both government and people, have not been aroused to an appreciation of this new science and have not attached to it the importance which it receives in other countries.

(*To be continued.*)

## RECENT LITERATURE.

**An American Book on Fungi.**—A few months ago the botanists of the country were greatly pleased with the announcement that J. B. Ellis and B. M. Everhart, the well-known publishers of the "North American Fungi," would soon bring out a book on the Black Fungi (Pyrenomycetes) a group presenting many difficulties to the student and collector. Early in May the work was completed and sent out to subscribers. It is a thick volume of about 800 octavo pages, accompanied by forty-one excellent plates, the latter the work of the lamented F. W. Anderson.

It is unnecessary to say here that this book will be useful. It could not be otherwise. Even the possessor of Saccardo's "Sylloge" must have this American work, and no beginner can afford to do without it.

For the help of beginners a freer use of synopses would have been useful, and it is to be hoped that such will be prepared for future editions.

The descriptions are full, and spore measurements are quite generally given, with many critical notes. Some changes in nomenclature are made, the merits of which need not be discussed in the present notice. It is pleasant to notice that the exact method of citation of authorities is followed, the name of the author first publishing the species being retained in parenthesis in case of a removal of the species from the genus in which it was first placed. In this connection the authors significantly remark that "the piratical practice of omitting the first name and substituting the second in its place can not be too strongly condemned."—CHARLES E. BESSEY.

**A Study of the Oak Tree.**[1]—If the pretty volume by Prof. Marshall Ward, recently brought out by Appleton, finds readers enough to warrant author and publisher in bringing out others, English speaking botanists will have cause for congratulating themselves upon the progress of botanical science among the people. Here is a strictly scientific popular book, confidently put forth by the publisher, at no little expense. That it should be brought out at all is a most encouraging sign, especially as it is not written to fill "a long felt want," nor is it

[1]The Oak, a popular introduction to forest botany, by H. Marshall Ward, M. A., F. R. S., F. L. S., Professor of Botany at the Royal Indian Engineering College.

designed to be used as a text book in the schools. It appeals to that constantly increasing class of intelligent readers and students who are interested in natural objects, and who cultivate natural history in the same way and for the same purpose as others cultivate literature, history or music. This growth of the study of nature as a means of broader culture is a significant feature in modern life, and books like the one under consideration will do much to foster and encourage it.—CHARLES E. BESSEY.

**The Horse. A Study in Natural History.**[1]—Mr. Flower's Study of the Horse is the second of the Modern Science Series, edited by Sir John Lubbock. The author, in his preface, refers to the number of works on horses and equitation, but offers as a reason for adding to their number the fact that knowledge has accumulated recently from various sources which enables the writer to treat the subject from the standpoint of an evolutionist.

The subject divides itself naturally into fossil and recent horses. The relations of each are discussed, and of the one to the other, so that the horse is shown, not as an isolated form, but as one term in a vast series.

The last two chapters are devoted to the structure of the horse. Since the anatomy has been so thoroughly worked out and so minutely described Prof. Flower has selected a few of the most important parts, describing them in language which may be understood by those who are not professional anatomists. Particular attention is given to the parts most specialized—viz., the teeth and limbs.

Prof. Flower is fortunate in having his book well illustrated by engravings from original photographs. That of the quagga is especially interesting as being from the only photograph known to have been taken of this animal in a living state.

Prof. Flower's account of the ancestry of the horse is in accordance with the latest paleontologic discoveries. He traces the line backward to Phenacodus, as is done by American paleontologists; but his suggestion that the European Hyracotherium is the same is not according to the evidence at present accessible as to the characters of the two genera. Prof. Owen's descriptions and figures of Hyracotherium sustain the view of Cope and Lydekker, that it is one of the Lophiodontidæ, and allied to Pliolophus.

[1]The Horse. A Study in Natural History, by William Henry Flower, London, 1891. Modern Science Series, edited by Sir John Lubbock.

**The Fur of Animals.**[2]—This volume forms one of a series on arts and trades, and the author has treated the subject from that point of view. He gives first the structure, form and coloration of the skins of those animals useful to man either for clothing or for furniture. To this is added a classification based on the uses to which the hides, hair, wool or fur is put. Following this technical part is a description of the animals mentioned, their haunts, the methods of hunting or trapping them, the principal markets and the prices paid for the pelts.

M. Lacroix–Dauliard has added much to the interest and value of his book by discussing the parasites that attack the skins, as well as those which injure the manufactured materials. The best known are the Dermestes, the Anthrenus, the Attagenus, the Teignes and the Acarians. Various ways of destroying these pests are mentioned, but the most effectual, in the author's judgment, is frequent exposure to light and air.

Eighty-nine well-shown figures illustrate the text and contribute much to the attractiveness of the book.

[2]Le Poil des Animaux et les Fourrures, Lacroix–Dauliard. Bibliothéque des Connaissances Utiles. Librarie J. B. Bailliére et Fils., 1892.

# General Notes.

## GEOLOGY AND PALEONTOLOGY.

**The Mexican Meteorites.**—Geologists are indebted to Mr. J. R. Eastman for a concise account of the Mexican meteorites. In a paper read before the Philosophical Society of Washington Jan. 2, 1892, he presented the latest and most complete information upon the subject, in a compact form convenient for reference. A list of the iron meteorites, with a table of their weights was given, followed by remarks as to the relative occurrence of iron and stony meteorites.

From the available data the ratio of weight of the former to the latter is as 1 to 12.23. The aggregate weight of meteoric iron observed and discovered to date on this continent is about 153 tons. If the above ratio is true in all cases there should have been a fall of about 1,880 tons of stony meteorites, or in all over 2,000 tons of meteoric matter precipitated upon the earth.

Mr. Eastman offers the following theory to account for the apparent excess of iron over stony meteorites: When a stony meteorite falls to the earth it generally breaks into many fragments, and the ruptured surfaces plainly indicate the nature of the catastrophe. The author knew of no case where an iron meteorite showed any indication of having been twisted, broken, or torn off from another mass of the same material.

The true type of meteorite which reaches the earth from outer space is probably like that which fell in Iowa county, Iowa, on Feb. 12, 1875. This meteorite is composed almost wholly of stony matter, but scattered through the mass are small grains of nickeliferous iron. This iron may exist in the stony matrix in all forms and sizes, from the microscopic nodule to the mass weighing several tons. When the stony mass comes in contact with the earth's atmosphere the impact breaks up the matrix, sets free the iron bodies and they reach the earth in the same condition, so far as mass and figure are concerned, as they exist in the original formation. In such cases it is probable that the stony portion of the original body is rent into such minute fragments by the explosion, that they would not reach the earth in any appreciable size. The larger the masses of iron the more complete would be the destruction of the original body, and the larger stony meteorites would be

those that contain the smaller granules of iron. (Phil. Soc. Washington, Bull. Vol. xii, pp. 39–52.)

**On the Separation and Study of the Heavy Accessories of Rocks.**—For the past few years Prof. Orville Derby, of the Geological Survey of Brazil, has employed the method of washing rock powder in water as the best means of isolating the accessory elements in rocks from the more abundant essential elements. His process differs from that of Cordier and Thurach in that he uses the batêa or Brazilian miner's pan instead of the glass or porcelain dishes of the laboratory.

The knack of washing is readily acquired, and the whole operation, from the preliminary crushing to the mounting of a microscopic slide, can be performed in a few minutes.

The delicacy of the process is well illustrated by the grouping of the minerals during the last stages of the washing. On throwing the sand out into a trail it will be found to be transversely streaked with different colors as the minerals arrange themselves according to their specific gravities. In a decomposed granite, for instance, the outer part will be white with quartz, then a reddish band of garnet, then a black band of titaniferous iron, and, finally (if magnetite be not present), a white band of zircon, or white and yellow if monazite is also present.

Prof. Derby's observations incline him to think that the use of the batêa will prove valuable in work which is more strictly geological, for the following reasons:

1st. Most of the prominent rock groups afford residues which are characteristic, either through the presence of accessories peculiar to each group, or by the relative abundance or peculiarities of form and structure of those that are common to several groups.

2d. Many of the most common heavy accessories are practically indestructible, and can therefore be recovered in recognizable form even when the rocks or their debris are so completely altered that their original type is not otherwise recognizable.

If rock types can be identified by their residues many rock masses can be taken into account which otherwise must be left out.

For purposes of identification only material decomposed *in situ* should be washed.

Prof. Derby also suggests that this method of study of the heavy accessories of rocks may be of value in investigating those rocks which have suffered alteration by metamorphism.

The kind and condition of a mineral constituent may be a means of distinguishing the metamorphosed eruptive from the metamorphosed sedimentary.

After discussing the subject in his usual comprehensive manner, Prof. Derby concludes that there is a reasonable probability that zircon, and to a less degree monazite, may prove to be guide minerals by which eruptives and their derivations can be certainly identified, no matter what degree of alteration they may have suffered. This probability gives additional interest to the study of the heavy residues of rocks which, it is hoped, will lead geologists to thoroughly test this hypothesis in other parts of the world. (Proceeds. Rochester Acad. Sci., Vol. i, pp. 198–206.)

**A Section of the Strata at Rochester, New York.**—A boring made by the firm of Otis & Gosline in a search for gas in the vicinity of Rochester, N. Y., has made known some interesting facts concerning the thickness of the rock strata of that region. The drill was sent to a depth in the rock of 3,078 feet, where the exceeding hardness of the rock made further progress very difficult. Small quantities of gas were found at various depths. A little brine was encountered at a depth of 1,330 feet.

From a carefully kept well record Prof. H. L. Fairchild has prepared the following condensed section of the Rochester well.

Altitude 484 feet above tide.

| Horizon. | Thickness. | Kind of Rock. | Depth. |
|---|---|---|---|
| Niagara | 156 ft. | Niagara limestone, Niagara shale, Clinton limestone | 156 ft. |
| | 22 ft. | Clinton upper green shale | |
| Clinton | 15 ft. | Clinton (Pentham) limestone | |
| | 35 ft. | Clinton lower green shale | 228 ft. |
| Red Medina | 1075 ft. | Red sandstones and shales | 1303 ft. |
| | 25 ft. | Blue shaly sandstone | |
| Oneida | 45 ft. | Hard gray sandstone | |
| (Oswego)* | 13 ft. | Dark gray shaly sandstone | 1386 ft. |
| Hudson and Utica | 598 ft. | Dark shales | 1984 ft. |
| Trenton | 954 ft. | Dark limestone | 2938 ft. |
| | 10 ft. | Gray limestone | |
| | 30 ft. | Drab limestone | |
| Calciferous? | 50 ft. | Dark gray limestone with shale | |
| | 44 ft. | Black magnesian limestone | |
| | 3 ft. | Dark calcareous shale | 3075 ft. |
| Algonkian? | 2 ft. | White quartz sandstone | |
| or Archean? | 1 ft. | Powdered ferruginous quartz | 3078 ft. |
| | 3078 ft. | | |

The fact that at the nearest exposures the calciferous lies directly upon crystalline rock is the author's reason for referring the last two doubtful rocks to the Algonkian or Archean. (Proceeds. Rochester Acad. Sci., Vol. i, p. 182.)

## MINERALOGY AND PETROGRAPHY.[1]

**The Eruptives of Cabo-de-Gata.**—The eruptive rocks of the Cabo-de-Gata region in southeastern Spain are pumiceous, glassy and granular liparites, andesites, dacites and an occasional basanite. The liparites are rare as fragments in a liparitic tufa and as small dykes cutting the fragmental rocks. The dacites cover a large stretch of country. They are the most abundant types in the region, and are developed in great variety. Two principal groups are distinguished. The first is characterized by the abundance of its phenocrysts, among which are large hornblendes, and by the possession of augite and hypersthene. Augite occurs in their groundmass, quartz is scarce, and their feldspar is almost exclusively plagioclase. In the second group phenocrysts are less common. Biotite is the predominant colored constituent. Quartz and sanidine are both plentiful and the rock thus verges toward the liparites. All the components of these dacites have been very minutely described by Osann.[2] But few of them present special peculiarities. The most interesting features connected with them are the alteration of hornblende into pyroxene and the intergrowth of augite and bronzite, with the pinacoids and prisms of the two minerals parallel. The andesites, which are best developed in the southern and southeastern parts of the region, are hornblendic and biotitic varieties. A mica andesite from the Rambla del Esparto contains an enormous number of granular inclusions composed of cordierite (?) biotite, spinel, sillimanite, corundum, andalusite, plagioclase, rutile, zircon, garnet, quartz and apatite. They are regarded as having resulted from the metamorphism of blocks brought from below, and the crystallization of andesite components upon them. The spinel occurs in dark-green and grayish-red crystals, the former sometimes surrounding the latter. A dacite from Mazarron contains phenocrysts of cordierite,[3] whose prismatic crystals often reach a length of 1 cm. The forms

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.

[2] Zeits. d. Deutsch. Geol. Ges. 1891, xliii, p. 688.

[3] Cf. AMERICAN NATURALIST, 1890, p. 69.

observed on them are $\infty$ P, $\infty$ P$\breve{\infty}$, $\infty$ P$\bar{\infty}$, oP, P, and $\frac{1}{2}$P. In the neighborhood of ore veins the mineral is changed into pinite.

**A Melilite Rock from North America.**—From the bed of the Ottawa River, near Ste. Anne, not far from Montreal, Can., Mr. Adams[4] has obtained the first melilite rock described from North America. It occurs as a dyke in Potsdam conglomerate. The rock, which has a fine-grained, dark groundmass, often contains phenocrysts of green and red olivine, biotite and pyroxene. The matrix in which these lie consists of small biotites, olivines and pyroxenes, between which lies a still finer aggregate of melilite, pyroxene needles and a small quantity of a colorless mineral that may be nepheline. Perofskite, apatite and magnetite are also present in it. The brown biotite is an anomite, with a small biaxial angle. It consists of an interior inclusion-free nucleus, usually with a rounded outline, surrounded by a zone filled with augite microlites and bounded by crystal faces. The olivine contains but little iron (12.65%). The red color of some grains is due to inclusions of iron oxide. Its alteration is sometimes into serpentine, but more frequently into ferriferous magnesite and breunerite, whose composition is Mg $CO_3$ = 64.83; Fe $CO_3$ = 26.16; Ca $CO_3$ = 1.66; impurities = 7.35. The alteration begins along cleavage cracks and proceeds inward from the peripheries of the olivine grains. The pyroxene phenocrysts are colorless and have an extinction of 42°. Like the biotite the augite grains are also bordered by a zone of a light brown color, which is of the same substance as that of the smaller phenocrysts and of the needles in the groundmass. The extinction in the zone is often 16° greater than that of the nucleus. The characteristic mineral of the rock, the melilite, possesses the peg structure and all the other peculiarities of this component of the Alnö specimens. Basal sections have rectangular or octagonal outlines, while prismatic sections are often flattened parallel to oP. The rock differs from the type alnoite in possessing no feldspar. The author thinks it is connected in some way with the Montreal volcanic center, forming Mt. Royal, which, as is well known, consists largely of eleolite syenites and related rocks. The composition of the rock follows:

| $SiO_2$ | $TiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | FeO | CaO | MgO | $K_2O$ | $Na_2O$ | $Co_2$ | $H_2O$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 35.91 | .23 | 11.51 | 2.35 | 5.38 | 13.57 | 17.54 | 2.87 | 1.75 | 9.40 | |

**The Sanidinite Bombs of Menet and Monac.**—The sanidinite bombs included in the trachytes of Menet, Cantal and of Monac,

[4]Amer. Jour. Sci., April, 1892, p. 269.

Haute-Loire, France, contain many interesting minerals, short descriptions of which are given by Lacroix.[5] In those from the first-named locality are vitreous orthoclase, anorthite microperthite, zircon in brilliant, transparent, wine-red and in colorless or brown and light rose crystals, sphene, apatite, corundum and biotite. The last named mineral is an original component of the rock yielding the bomb, while the zircon, sphene and apatite are certainly new products. The Monac sanidinites differ from those of Menet principally in being saturated with secondary substances.

**Igneous Rocks from Montana.**—Among the rocks found in the mountains of Montana and described by Lindgren[6] are dacite, trachytes, basalts and augite-syenites. One variety of basalt consists of fresh olivine, augite and analcite in a groundmass composed of magnetite, apatite andanalcites of a second generation. The rock was described in one of the Tenth Census Reports, where the analcite was stated to be in all probability an alteration product of nosean. The author now regards the mineral as unquestionably original.

**Petrographical News.**—Mr. Cole[7] describes a section of devitrified perlitic obsidian from Rocche Rosse, Lipari, in which the rock is much shattered. Around the fragments of glass thus formed spherulitic substance has resulted from the devitrification of their material. Beginning at the cracks separating the fragments the devitrification has progressed inward until a spherulitic zone now surrounds each piece of glass.——The mica schist[8] around the granite of the Schneekoppe in the Riesengebirge, Silesia, has been changed by the eruptive from a muscovite-garnet-quartz-schist to a schistose aggregate of quartz, muscovite, biotite, andalusite, and new, blood-red garnets. The biotite is in isolated small plates that are quite different in character from the flakes of muscovite adhering to the quartz grains in the original rock.——A few augite, saussurite and quartz diorites, a gabbro and several porphyries, porphyrites and diabases from the hills surrounding the Muir Glacier, in Alaska, are briefly described by Williams[9] in an appendix to Reid's account of the glacier.——In the olivine diabase of a dyke cutting the Sioux quartzite, in Minnehaha Co.,

[5]Bull. Soc. Min. d. Fr., xiv, 1892, p. 314.

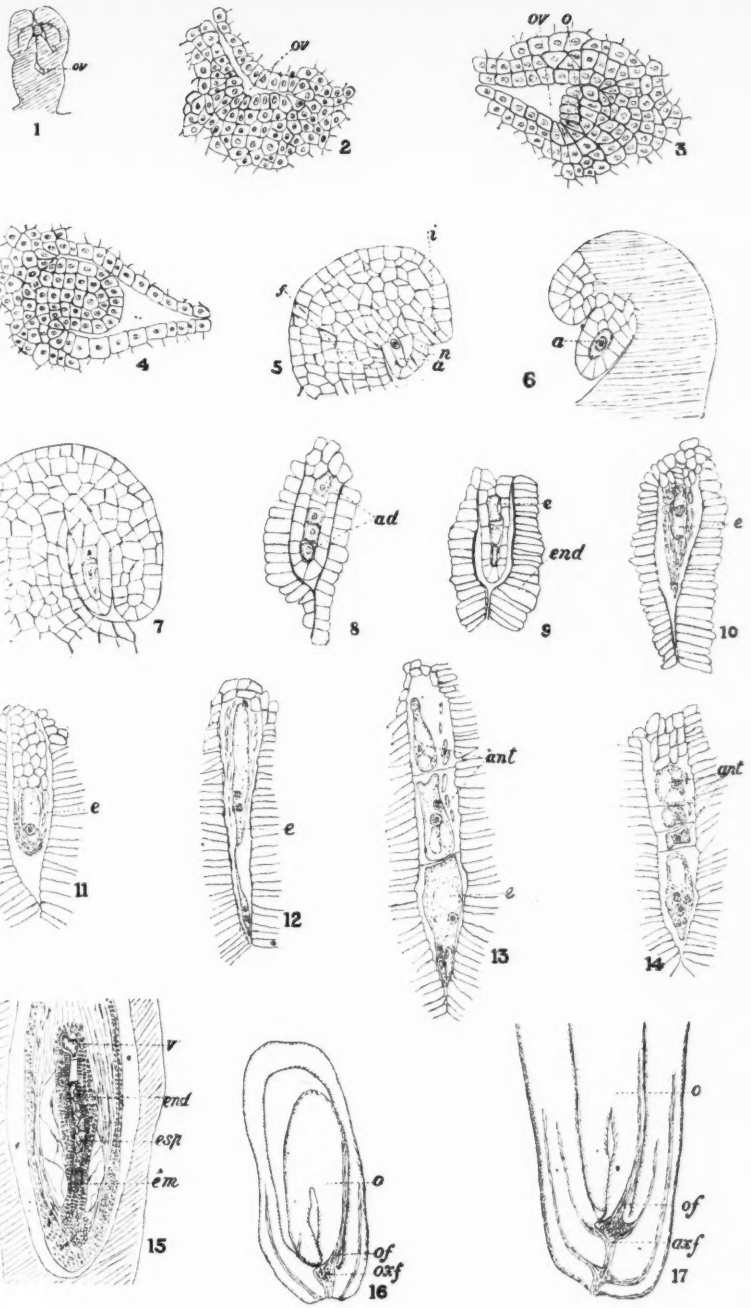
[6]Proc. Cal. Acad. Sci., 2, vol. iii, p. 39.

[7]Mineralogical Magazine, ix, p. 272.

[8]Zeits. d. Deutsch. Geol. Ges. xliii, 1891, p. 730.

[9]Nat. Geog. Mag., Washington, iv, p. 63.

# PLATE XX.




Norris, on *Grindelia*.

S. Dak., Messrs. Culver[10] and Hobbs find that the reddish to yellowish-brown diallage is strongly pleochroic.

**Mineralogical News.**—*General Crystallographic.*—Wyrouboff, in the continuation of his crystallographic study of closely related double salts of sulphuric, selenic and chromic acids, has reached some exceedingly interesting results bearing upon isomorphism. After carefully measuring the crystals of ten of these compounds and comparing their optical properties, he finds that while several of them are crystallographically similar these same compounds possess quite different optical characteristics. Fe $K_2(SO_4)_2$, Mn $K_2(SO_4)_2$ and Mn $K_2(SeO_4)_2$ are optically as well as morphologically similar. Since the optical properties of crystals change when they are subjected to changes of temperature it follows that these properties are dependent upon the arrangement of the molecules—upon the character of the crystal network. Isomorphous bodies are those that possess identical networks, consequently isomorphous bodies are those that are similar morphologically and at the same time optically, and in which the changes suffered under similarly changed conditions are similar. The magnesian sulphates with seven molecules of water are good examples of a truly isomorphous group. There is another kind of isomorphism embracing those bodies in which the morphological properties are similar but the optical ones different. In such bodies, since the arrangements of the molecules in the two intermingled substances are different, there should be evidence in these of optical anomalies, which are not apparent in the simple compounds, and this is found frequently to be the case. A further conclusion drawn by the author from his experiments is to the effect that while in general, substances whose chemical composition is analogous have similar crystalline forms, it does not necessarily follow that isomorphous bodies possess analogous compositions; they need merely to be built upon the same plan, possess identically arranged networks. Many of the views put forth in the paper are novel, and some of them are rather startling. We shall look forward with much interest to their discussion by German mineralogists.——The relation between symmetry and the chemical composition of crystals continues to attract the attention of mineralogists theoretically inclined. Fock[11] now suggests that the method by which the problem is to be attacked is through the aid of stereochemistry. He assumes that the crystal particles have the same symmetry as the crystal individual, and seeks

[10]Trans. Wis. Acad. Sci., viii, 1891, p. 206.

[11]Zeits. f. Kryst., xx, p. 76.

to trace the symmetry of the particle to the symmetry of the chemical molecule as its source. According to the conception of most chemists the carbon atom may be represented by a point with four bars extending toward the four corners of a circumscribed tetrahedron. The symmetry of the carbon molecule is thus comparable with the symmetry of the crystallized carbon—diamond. With this suggestion as a basis the author shows how the crystallization of graphite and of some of the carbonates may be explained, but at the same time he confesses that few practical results can follow from the suggestion until we know more about the composition of solid substances.

*Notes.*—An attempt to discover the reason for the variation in the pyramidal angles of *arsenopyrite* and to settle its composition has been made by Weibull,[12] who has examined crystals from Silfberg, Delane, and other localities in Sweden, and from the well-known occurrences in Europe. Among the Silfberg crystals three types were recognized, on the first of which the predominant forms are $\infty P$ and $P\breve{\infty}$. Their axial ratio is .6841 : 1 : 1.1910, and composition (Fe Co Ni) $(S\ As)_2$. On the second type the same forms are observed with the addition of $\frac{1}{2}P\breve{\infty}$, but the crystals are usually prismatic parallel to $\breve{a}$. Their axial ratio is .6830 : 1 : 1.1923 and composition Fe S As. Crystals of the third type are long prismatic in the direction of *c* and are bounded by the same planes as are found in the second type. Their axial ratio is .6724 : 1 : 1.1896. Crystals from other localities show differences in composition and in axial ratio, and these differences are expressed in differences in habit. The formula best representing the composition of the mineral is thought to be $Fe(S\ As)_2$, and variations from it are thought to be due to inclusions in the material analyzed. If $Fe(As\ S)_2$ be considered the normal arsenopyrite ten per cent. of $Fe\ S_2$ may be replaced by $Fe\ As_2$, or the reverse, and the replacement will affect the axial ratio to a noticeable extent, an increase in $Fe\ S_2$ tending to increase the lengths of *a* and *c*. The substitution of Co and Ni for Fe affects the axes in the same way.——In an exhaustive article on the mineral deposits of Leogang in Salzburg, Buckrucker[13] gives a brief account of the region and a detailed description of the many minerals occurring therein. Thirty-two distinct species are referred to in the article, some briefly, others very extensively. Among the latter are *dolomite, aragonite, strontianite* and *celestite.* $2\ E_{Na}$ for aragonite is 30° 43.5′. $2\ V_{Na}$ for strontianite is 6° 59′ 12″

[12]Ib., p. 1.

[13]Zeits. f. Kryst. xix, p. 113.

and 2 E $_{Na}$ for celestite is 87° 40′ 20″.——Mügge[14] has made an interesting study of quartz crystals imbedded in eruptive rocks. These were isolated by treatment of thin slices of the rocks with HF, and the etched figures produced upon them by the reagent were investigated. Of 888 individuals examined 382 were found to be simple, 506 twins of either right or left handed crystals, and 12 twins of right and left crystals. Pyrogenous quartzes like those deposited from solution are thus found to be more common in twinned than in simple forms. ——Lacroix[15] contributes a few notes on French minerals, especially those from the Central Plateau. He finds *leucite* forming veins in the basalt of Mt. Doré, with peripheral bands of feldspar. *Christianite* crystals imbedded in calcite occur in calcified inclusions in a basalt dyke at Montaudoux, Puy-de-Dôm. The same mineral is in the sanidinite bombs of Monac, and is associated with chabasite at Araules in the Haute-Loire. *Mesotype, analcite, zircon, sphene, vivianite, molybdenite, kermesite* and *pyrite* are the other minerals mentioned in the article.——Schrauf[16] describes the *metacinnabarite* crystals of Idria, Austria, and discusses their origin as well as that of the associated mercury and cinnabar. The crystals have a density of 7.66. They form the outer coating of spherules that within are massive metacinnabarite. Their crystallization is regular and habit dodecahedral.—— Pearce[17] calls attention to the existence of tellurium and bismuth in nearly all the sulphides of the Leadville region.——Hills[18] recently exhibited to the Colorado Scientific Society pseudomorphs of malachite after azurite on which are implanted crystals of a second generation of the last named mineral with the same orientation as the original azurite.——Lacroix and Baret[19] find *bertrandite* at Mercerie in the Commune of La Chapelle-sur-Erdre, France. Its crystals are elongated parallel to the base, and are associated with orthoclase, albite, quartz and apatite in a granite.——The supposed sulph-antimonite of nickel, *korynite*, from Siegen, according to an analysis made by Laspeyres and Busz,[20] is a normal ullmanite, whose composition is:

[14]Neues. Jahrb. f. Min., etc., 1892, i, p. 1.

[15]Bull. Soc. Franç. d. Min., xiv, p. 318.

[16]Jahrb. d. k. k. geol. Reichsanst., 1891, xli, p. 349.

[17]Proc. Col. Sci. Soc. 1890, iii, p. 257.

[18]Ib., p. 258.

[19]Bull. Soc. Franç. d. Min., xiv, p. 189.

[20]Zeits. f. Kryst., xix, 1891, p. 8.

| S | Sb | As | Bi | Fe | Co | Ni | Sp. Gr. |
|---|---|---|---|---|---|---|---|
| 16.22 | 42.93 | 10.28 | .68 | .40 | 1.13 | 28.91 | 6.488 |

——A rose-red *tourmaline*[21] from Urulga, Siberia, has a composition corresponding to the formula 12 $SiO_2$, 8 $Al_2O_3$, 3 $B_2O_3$, 2(FeO MnO), $Na_2O(K_2O\ Li_2O)$, 3 $H_2O$.——Genth[22] has revised Kerr's report on the minerals of North Carolina, and has published the amended and enlarged revision as a Bulletin of the Survey. All the minerals known to occur within the State are mentioned and described briefly, and a synopsis of the mineral wealth of the different counties is given in tabular form.——The sixth part of Hintze's Handbuch der Mineralogie has recently appeared. It discusses serpentine, nepheline, kaolin, sodalite, cordierite and related minerals.——A series of new measurements of *wollastonite*[24] crystals from Vesuvius adds considerable to our accurate knowledge of their morphological characteristics.

[21]Stchusseff. Ib., xx, p. 93.

[22]Bull. U. S. Geol. Survey No. 74, Wash., 1891.

[23]Zeits. f. Kryst., xix, p. 604.

## BOTANY.

**Development of the Ovule in Grindelia squarrosa.**—The ovule in *Grindelia* arises by tangential division of the cells of the first, second and perhaps third hypodermal layers, resulting in an up-pushing of the floor of the ovarian cavity (figs. 1–4). As Coulter[1] says of *Taraxacum*, the ovule does not appear exactly at the bottom of the cavity of the ovary, but a little at one side. The ovule springs from the axis of the flower as is shown by the passing of the fibrovascular bundle directly from the axis to the funiculus. In this respect *Grindelia* agrees with *Helianthus* (figs. 16 and 17) and differs from *Taraxacum* in which, according to Coulter, the fibrovascular threads of the funiculus come from a carpellary branch of the axis. The young ovule early begins to curve upon itself, the single integument appears on the upper convex surface and, by growth beyond and around, completely enwraps the apex of the ovule, the nucellus (figs. 5–7). At this time we distinguish three portions of the ovule—funiculus, integument and nucellus. The nucellus consists of an axial row of cells covered by the epidermis. In the apex of the nucellus, immediately beneath the epidermis, is the archesporium (figs. 5 and 6). This divides into two and then four cells (figs. 7 and 8). By accelerated growth the most deeply situated of these cells absorbs or pushes the others toward the apex of the nucellus and becomes the embryo-sac (figs. 9–11). At the same time the epidermis of the nucellus shrinks and disappears. Concomitant with the degeneration of the nucellar epidermis the adjacent layer of the integument becomes greatly modified, forming what Hegelmaier[2] terms the "Endodermis." Its cells lengthen radially, and the cell walls become much thickened and resistant to the section knife. Of the stages between the embryo-sac with but one nucleus and the mature state of the same I have found few representatives. Enough was seen, however, to indicate that the typical order is followed (figs. 12–14). The nucleus undergoes a three-fold division. A tetrad is seen in the micropylar end. The usual number of the antipodal cells is two (fig. 13), though rarely a third is seen (fig. 14). They are situated in a linear series with the embryo-sac, being early

[1]Development of a Dandelion Flower, AMERICAN NATURALIST, Vol. xvii, No. 12, Dec., 1883.

[2]Über den Keimsack einigen Compositen und dessen Umhüllung. Bot. Zeitung. Nos. 50–52, 1889.

marked off from the latter by distinct cell walls. They persist for some time after fecundation, and as in *Helianthus*, send out vermiform protoplasmic extensions that assist in tearing down the adjacent tissues. Shortly prior to fecundation the tissue just outside the endodermis begins to degenerate by losing its protoplasmic contents. With the development of the endosperm and the growth of the embryo, this absorption of the tissue of the ovule proceeds to such an extent that, as Hegelmaier[3] notes in *Helianthus*, the endodermis, with its contents, can be removed with ease. While this is going on the one-layered endodermis has become many layered except at its micropylar and antipodal ends (fig. 15). Its cells become rich in protoplasm at the expense of the surrounding tissue now rapidly becoming depauperate. The suggestion of Hegelmaier that this condition in *Helianthus* may be due to cultivation, etc., is of little value, since the same condition occurs in *Grindelia* and also in uncultivated *Helianthus*. Later, as the seed matures, the endodermis as such disappears, being represented only as a thin, compressed coat of the embryo.

It is thus seen that the development of *Grindelia* agrees closely with that of *Senecio* described by Warming[4] and Vesque,[5] though the latter of course was considerably in error. *Conyza*, described by Guignard[6] has a similar development, but the antipodal cells are more numerous than in *Grindelia*. *Helianthus*, studied by Hofmeister,[7] and later by Hegelmaier,[8] agrees very closely with *Grindelia*. As in *Helianthus* the endodermis is strongly developed, in marked contrast to *Ageratum* where it is scarcely differentiated. Hegelmaier observes in the mature embryo-sac of *Senecio* five nuclei: the two synergidæ, the oösphere, and two secondary nuclei of the embryo-sac. The same is seen in *Grindelia*.

In a short notice of this kind, for the most part merely confirmatory of similar studies of others, it seems hardly worth the while to

[3]Loc. cit.

[4]De l'Ovule. Ann. Sc. Nat. 6, Sér. v. 1878, p. 176.

[5]Développement du sac embryonnaire des Phanérogames, Ann. Sc. Nat. 6 sér., vi, 1878, p. 237. Nouvelles recherches sur le développement du sac embryonnaire des végétaux phanérogames angiospermes. Ann. Sc. Nat. 6 sér., viii, 1879, p. 261.

[6]Recherches sur le sac embryonnaire des Phanérogames. angiospermes. Ann. Sc. Nat. 6 sèr.. xiii, 1882, p. 136.

[7]Entstehung des Embryo. Leipzig, 1849,

Neuere Beobachtungen über Embryobildung der Phanerögamen. Pringsheim's Jahrbücher, i, 1858, p. 82.

[8]Loc. cit.

attempt to give titles of even the most important of the literature on the subject.—H. W. NORRIS, Grinnell, Iowa.

EXPLANATION OF FIGURES, PLATE XX.

Abbreviations used.

*a*, archesporium; *ad*, daughter cells of archesporium; *ant*, antipodal cells; *axf*, fibrovascular bundles of the axis of the flower; *e*, embryo-sac; *em*, embryo; *end*, "endodermis;" *esp*, endosperm; *f*, funiculus; *i*, integument; *n*, nucellus; *o*, ovule, *of*, fibrovascular bundle of ovule; *ov*, cavity of ovary; *v*, part of vermiform extension of protoplasm of an antipodal cell.

Figs. 1–16 are of *Grindelia squarrosa*.

Fig. 17 is of *Helianthus annuus*.

## ZOOLOGY.

**Notes on a Nematode Parasite from the Chipping Sparrow** (*Spizilla socialis*).—I have received from Mr. Wm. B. Marshall, Albany, N. Y., a parasite from the thoracic cavity of the chipping sparrow which appears to be new.

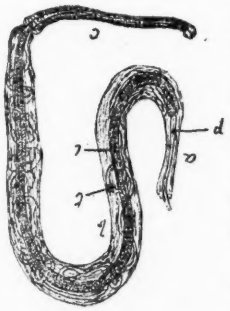


FIG. 1.

The sparrow was shot by Mr. Marshall on May 14, 1892, and the worm was found lying directly against the heart of the bird. The color of the worm while alive was a brilliant red. It is a male; the head is damaged but otherwise the specimen is perfect.

Although the diameter of this specimen is proportionally many times greater than that of any recorded species of *Trichosoma*, the body being not at all hair-like; and although the posterior spicule and its sheath present some difficulties when compared with descriptions of the various species of *Trichosoma* and the related genus *Trichocephalus*, I prefer to refer the specimen to the former genus, to which it is certainly closely allied, rather than to erect a new genus for its accommodation. I therefore place the specimen provisionally in the genus *Trichosoma* and propose the name *Trichosoma rubrum* for it.

The specimen has the following characters: Body cylindrical, with somewhat yielding walls, and presenting three distinct regions; an

anterior region, slender and containing the œsophagus; a thicker median region, containing the dark-brown intestine and the convoluted generative tube; a posterior slender region sharply marked off from the median region by a constriction, containing the uncolored posterior portion of the intestine and the posterior portion of the generative tube. The latter region terminates in an enlarged and gibbous copulatory bursa, which is denticulate with about two rows of blunt teeth on its rim, and contains a single, club-shaped spicule. The anterior and median regions are smooth or with faint longitudinal striations; the posterior region is transversely wrinkled.

FIG. 2.

The œsophagus is straight, slender and communicates by a rounded base with the intestine, which is broader than the œsophagus, abruptly truncate at its origin and continues of nearly uniform size throughout the median portion of the body. The walls of the intestine in the median region of the body were seen to contain polygonal, mostly hexagonal, cells [Fig. 5]. The intestine loses its dark-brown color as it passes from the median to the posterior region of the body. The anal aperture is at the base of the copulatory bursa [*a*, Fig. 3]. The generative apparatus is a single tube which extends from the anterior end of the intestine to the copulatory bursa, where it opens beside the papillary termination of the intestine, [*vd*, Fig. 3]. In the central region of the body it is much convoluted; in the posterior region of the body it is nearly straight and thick-walled.

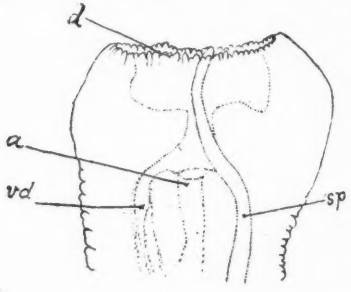



FIG. 3.

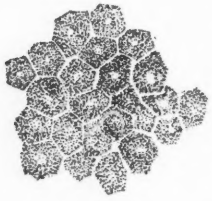


FIG. 5.

The spicule [Figs. 2, 3, 4], is club-shaped, somewhat spiral in its middle portion, about twice the length of the bursa and less than one-fifth the length of the posterior division of the body.

FIG. 4.

The following measurements were made on the specimen in acetic acid:

| | Millimeters. |
|---|---|
| Length | 25.00 |
| Length of anterior division or neck | 2.20 |
| Length of median division, body proper | 17.30 |
| Length of posterior division | 5.50 |
| Diameter, median | 0.90 |
| Diameter, anterior end | 0.42 |
| Diameter, 1mm. from anterior end | 0.32 |
| Diameter of bursa | 0.36 |
| Length of spicule | 0.42 |
| Diameter of spicule, apex | 0.01 |
| Diameter of spicule, middle | 0.015 |
| Diameter of spicule, base | 0.04 |

The anterior division of the body or neck passes by rather abrupt enlargement into the body proper. The diameter of the œsophagus at base is 0.18 mm; and the breadth of the intestine at its anterior end is 0.3 mm.

The posterior, transversely-wrinkled portion may, possibly, be retractile, although the appearance is against this supposition.

The single specimen, upon which this description is based, is in the possession of Mr. Wm. B. Marshall, State Museum, Albany, N. Y.

EXPLANATION OF FIGURES.

Fig. 1. Specimen, head missing, x 6. *a*, neck; *b*, body; *c*, posterior region of body separated from body proper by a constriction; *p*, œsophagus; *i*, intestine; *t*, reproductive tube.

Fig. 2. Bursa and spicule, x 75.

Fig. 3. Bursa, optical section, x 150, *a*, anal aperture; *d*, denticulate rim; *sp*, spicule; *vd*, termination of reproductive tube.

Fig. 4. Portions of spicule, x 200, *a*, apical, and *b*, basal portions.

Fig. 5. Polygonal cells in wall of dark-brown portion of intestine, x about 150.

EDWIN LINTON, PH. D.
Washington and Jefferson College.

Washington, Pa., June 1, 1892.

## EMBRYOLOGY.[1]

**The Development of Paludina vivapara.**[2]—R. von Erlanger contributes two papers on this subject which form a comprehensive and valuable study of the development of this species. He describes concisely and clearly the development of the tissues and organs, giving special attention to the origin of the mesoderm and to the formation of the pericardium, heart, primitive kidneys, permanent kidneys, renal ducts, reproductive organs, and nervous system. The author had an abundance of material and believes he was able to fully verify all his results. Heretofore no one has succeeded in keeping alive the embryos after removing them from the opaque albuminous capsule which encloses them. The author found they would live for a time in a solution of 20cc. of egg albumen, 1g. of common salt and 200cc. of water; so that he was able to observe the processes of development in the living embryo. Of the fixing agents used Kleinenberg's picro sulphuric acid with a drop of 5% osmic acid added was by far the most successful.

The mesoderm arises from the archenteron at the time of the formation of the velum. The ventral wall of the archenteron pushes out as a single large sac, which soon pinches off from the rest of the entoderm. For a time it has the form of a closed vesicle lying in the ventral half of the embryo between the ectoderm and entoderm. This vesicle enlarges, its cells becoming somewhat flattened in the process. Later the walls of the vesicle break up into their constituent cells, the disintegration beginning at the mid-ventral point of the vesicle. Some of the cells apply themselves to the ectoderm (somatopleure), some to the entoderm (splanchnopleure), others, star shaped, form an extensive net-work filling the segmentation cavity; processes from the somatopleuric and splanchnopleuric mesoderm cells also join the net-work. The different organs now begin to make their appearance. The coelom of Paludina, according to this description, arises as a single, median, ventral evagination from the archenteron.

At the time when the rudiment of the stomadæal invagination appears there can be seen in the posterior part of the embryo, below

[1]This department is edited by Dr. E. A. Andrews, Johns Hopkins University.

[2]Zur Entwicklung der Paludina vivapara. R. von Erlanger, Morph. Jahrb., vol. xvii, 1891; Part I, August; Part II, October.

the ventral wall of the gut, a paired mass of spindle-shaped mesoderm cells (each half of this mass of cells contains a cavity). This is the rudiment of the pericardium. It varies greatly in different individuals, but always has a paired origin. The two halves fuse later, but for a considerable time there remains a septum between the cavities of the two sides. The right cavity is from the first the larger of the two. Erlanger says: "I was not able in Paludina to see the immediate transformation of the coelom into the pericardium, since the whole secondary body cavity is so early wholly filled with irregularly disposed, spindle-shaped mesoderm cells; yet the rudiment of the pericardium is formed between the two mesoderm layers, one of which clothes the inner surface of the ectoderm, the other the outer surface of the gut.

"The question then arises whether the pericardium represents the whole secondary body cavity (which would be greatly reduced) or merely a part of it, so that then the rest of the coelom would coincide with the primary body cavity or segmentation cavity. I now incline toward the second view, and think that the coelom only partially persists as such in the pericardium, while by far the greater part of it is obscured by the spindle-cells which fill it and so simulates the primary body cavity [—und daher sich mit der primären Leibeshöhle deckt]. The development of Paludina, described in this paper, appears to me to uphold this conclusion, and my other not yet completed researches in regard to the manner of formation of the blood-vessels strengthens me in this view."

The kidneys arise as evaginations, right and left, of the pericardial wall, while the embryo is still untwisted. They are first indicated by thickened areas of this wall. These thickened areas push out toward the mouth chamber until they assume a tubular form. The rudiments of the renal ducts arise at the same time with the latter, as evaginations, right and left of the walls of the mantle chamber, toward the rudiments of the kidneys. The right kidney rudiment and the rudiment of the right renal duct unite to form the permanent kidney. The left kidney is never fully formed, its rudiment never uniting with that of the left renal duct. Each of these persist for a time, but during the subsequent spiral twisting of the embryo each is obliterated. The secretory portion of the kidney arises then, from mesoderm and not from ectoderm, as has been claimed. Its excretory duct arises from the ectoderm of the mantle chamber.

The heart arises as an invagination of the dorsal area of the pericardium, forming an antero-posterior furrow. Soon this furrow con-

stricts in the middle, indicating the line of demarkation between auricle and ventricle. The heart furrow sinks more and more into the pericardial sac until it becomes a closed tube distinct from the latter, except at its two openings, one on the originally anterior, the other on the originally posterior face of the pericardium. At the same time the heart has divided into an auricle (posterior) and a ventricle (anterior), as was before indicated by the constriction in the heart furrow.

By the twisting of the body of the embryo the heart is brought upon the left side and the kidney to the middle line. The kidney grows larger, its opening into the pericardium becomes narrower, and the external orifice of the renal duct grows smaller and smaller. At the same time the cells of the wall of the kidney enlarge and in different places the walls push into the lumen of the gland, forming strands which by further development are converted into a mass of spongy tissue. The kidney, then, is not a typical acinous gland.

The primitive kidneys ("Urnieren") arise from mesoderm, one on each side of the embryo, just behind the velum. They first appear at the time of the stomadæal invagination, while the embryo is still wholly symmetrical. Each rudiment is at first a solid mass of cells. Soon a cavity appears within the mass, and at the same time it approaches the surface. It soon breaks through the ectoderm cells to the surface. Its cells can be distinguished from the ectoderm and the rest of the mesoderm by their large size, clear protoplasm and deeper staining. It is still a closed vesicle. Now it elongates, becoming tubular, and soon it gains an external opening. There is no internal opening for the primitive kidney. Its inner end is formed by a mass of spindle-shaped and star-shaped mesoderm cells, at least one of which bears long cilia, which are active in the living embryo. No concretions or excretory granules are present. In the absence of any internal opening the primitive kidney of Paludina resembles the excretory organs of Plathelminths, "yet it may be possible that this departure from the ordinary condition is only the result of a certain degeneration." Erlanger thinks that in the pair of primitive kidneys and the pair of permanent kidneys (only one of which fully develops) we may have represented the segmental organs of two segments, comparable to the segmental organs of the worms.

The author shows that each of the ganglia of the nervous system arises by a sort of delamination from thickened areas of the ectoderm. All but the visceral ganglion arise from paired rudiments. The vis-

ceral ganglion arises from a single thickening of the wall of the mantle chamber near the pericardium.

There is no "Scheitelplatte," the two rudiments of the cerebral ganglia being from the first distinct. They arise by delamination from two distinct thickenings of the ectoderm of the pre-velar area, situated one on the right, one on the left of the centre of the area.

The pedal ganglia next appear, arising in the same way by delamination from two distinct ectodermal thickenings. The pallial ganglia develop from similar paired rudiments. The buccal ganglia are formed later from paired thickenings of the ectoderm of the ventral wall of the stomodæum. Two thickenings of the anterior border of the mantle give rise to the two intestinal ganglia, which are at first right and left. The twisting of the embryo soon brings the right one above the intestine (supraintestinal ganglion) and the left one below (subintestinal ganglion). The subintestinal ganglion does not appear in the adult. The visceral ganglion is formed from the posterior part of the floor of the mantle chamber. It arises from the ectoderm, but does not have a paired origin, differing in this respect from all the other ganglia.

As seen in the order of description, the ganglia arises progressively from before backward. The commissures and connectives arise in the same order. The cerebral ganglia first connect with each other, then with the pallial, the pedal and the buccal ganglia. The pedal ganglia next unite and then the buccal ganglia. No commissure connects the pallial ganglia. Of all the connectives between the cerebral ganglia and the other nerve centres the cerebro-pedal connectives are the last to appear. This is the only exception to the rule that the nervous system develops progressively from before backward. Because of the small size of the ganglion cells Erlanger was unable to demonstrate the origin of the nerve fibres.

"The circulatory system of Paludina arises in the manner typical for the Mollusca."

The origin of the sexual organs is interesting. It is the same in both sexes. The ovary, or testis, is formed from an evagination of a portion of the pericardium, almost, or exactly, in the place where earlier the rudimentary left kidney was formed. The duct arises as did the rudimentary left renal duct and from the same region of the mantle chamber. The tubular rudiment of the "sexual gland" separates from the pericardium and forms a hollow vesicle, which, later, connects with the sexual duct. The sexual organs are formed, then, apparently by the reopening of the left kidney, which appeared and

atrophied at an earlier stage in the development. This manner of development, though peculiar, corresponds fundamentally to the Molluscan type. The renal ducts probably originally served as sexual ducts also (e. g. Chiton). In Paludina we have, associated with the twisting of the body, a differentiation in function, by which the right uro-genital duct comes to serve simply as a renal organ and the left as a sexual organ.

Among the most valuable features of this paper is the review of the literature of the subject. The author's discussion of the relationship of the Mollusca to the annelids and flat worms is not so important. Many points in the paper and some whole sections (e. g. the development of the sense organs) have been passed over in this brief review. I trust, however, that reference has been made to the points of special interest, and such points are not few. The author's clearness and conciseness of statement make his paper a very readable one.—MAYNARD M. METCALF.

## ENTOMOLOGY.

**Classification of the Mites.**—A paper of much value to students of the Acaroidea has recently been published[1] by Dr. Trouessart. It is entitled "Considérations générales sur la classification des acariens, Suivies d' un essai de classification nouvelles." The author first gives a historical sketch of the classifications that have been proposed for the group, from that of Latreille in 1795 to that of Canestrini in 1891. He then discusses the characters upon which the classification should be based, gives the tabular statement of his new classification (translated on the following page) and concludes with a useful review of the families, subfamilies and genera, with the characters of the families and subfamilies. Dr. Trouessart thinks the mites should form the sub-class Acaroidea, of the class Arachnida, and divides them into two orders, the Acarina and the Vermiformia.—C. M. W.

**Color Preferences of the Carpet Beetle.**—During the past May the Buffalo carpet beetles (*Anthrenus scrophulariæ*) have been abundant on the tulip beds at Hanover, N. H., taking advantage, no doubt, of the open windows of the house-cleaning period to fly out and get some pollen for food. In a small bed containing about three dozen tulips, three-fourths of which were of red colors, and the rest of white and

[1]Revue des Sciences Naturelles, 1892.

| Orders. | Sub-orders. | | Families. | Sub-families. |
|---|---|---|---|---|
| Sub-class Acaroidea. | Order I. **Acarina.** Abdomen entirely united with cephalothorax. | A. Tracheæ opening on anterior portion of body (rostrum or thorax). **Prostigmata.** Atrophied in aquatic types. Body having epimera below. | Palpi free, armed; mandibles hooked or styliform. | Terrestrial 1. *Trombidiidæ* | Erythræinæ, Trombidinæ, Cheyletinæ, Sciirinæ, Tetranycinæ, Cæculinæ, Limnocharinæ |
| | | | | Fresh w. 2. *Hydrachnidæ* |
| | | | | Marine 3. *Halacaridæ* |
| | | | Palpi free, unarmed; mandibles in form of cheliceræ. | 4. *Bdellidæ* | Bdellinæ, Eupodinæ |
| | | B. Tracheæ opening at posterior part of body, at the base of the feet. **Metastigmata.** Body having a ventral sternum or plastron. | Palpi free, unarmed, tactile; mandibles hooked. | 5. *Gamasidæ* | Nicoletiellinæ, Uropodinæ, Gamasinæ, Dermayssinæ |
| | | | Palpi tactile, mandibles hooked; mandibles in form of cheliceræ. | 6. *Ixodidæ* | Argasinæ, Ixodinæ |
| | | | Palpi free, tactile, fusiform. | 7. *Oribatidæ* | Oribatinæ, Nothrinæ, Hoplophorinæ |
| | | C. No tracheæ. **Astigmata.** Body having epimera below. Palpi adhering at their base, slender, tactile; mandibles in form of cheliceræ. | | 8. *Saracoptidæ* | Tyroglyphinæ, Canestrininæ, Listrophorinæ, Analgesinæ, Sarcoptinæ, Chirodiscinæ |
| | Order II. **Vermiformia.** Abdomen distinct from cephalothorax, ringed. No tracheæ. | A. **Octopoda.** 4 pairs feet, palpi armed, mandibles styliform, immovable. | | 9. *Demodicidæ* | |
| | | B. **Tetrapoda.** 2 pairs of feet, palpi unarmed, mandibles styliform, movable. | | 10. *Phytoptidæ* | |

yellow, the beetles were found almost exclusively upon the latter varieties, apparently preferring white to yellow, and undoubtedly choosing one of these in preference to the red. On bright days a dozen would sometimes be found in a single white tulip, and two or three hundred beetles were collected from the patch.

It is probable that at the time these visits were made the beetles had not yet laid their eggs. Some were observed mating. Consequently gathering and destroying them on these early spring blossoms is a simple means of checking their increase. I saw a few on white and yellow crocuses, but none on other flowers, wild or cultivated, except the tulips.—CLARENCE M. WEED.

**Association of Economic Entomologists.**—Mr. F. M. Webster, Secretary, has issued the following announcement concerning the next meeting of this body: In accordance with an action of the Association, taken at the Washington meeting, the fourth annual meeting will be held at Rochester, New York, two days prior to the meeting of the American Association for the Advancement of Science.

All members intending to present papers are requested to forward titles to the Secretary before August 1st, in order that the program may be prepared in proper season.

The proceedings of our meetings are attracting the attention of working entomologists of other countries, and it is to be hoped that members will spare no efforts to make the coming meeting even better than those which have preceded it. Owing to the continued ill-health of President Lintner, and in order to relieve him of as much labor as possible, all correspondence, unless of a nature necessitating his attention, may be addressed to the Secretary, at Columbus, Ohio.

**Dr. Lintner's seventh report** on the injurious and other insects of the State of New York has lately been published. It covers the year 1890, and forms a very creditable volume of more than 200 pages. The injurious insects treated of include the poplar saw-fly (*Aulacomerus lutescens*), the black and red woolly bear (*Pyrrharctia isabella*), the prolific Chlorops (*C. prolifica*), the chrysanthemum fly (*Phytomyza chrysanthemi*), the bean weevil (*Bruchus obsoletus*), the lentil weevil (*Bruchus lentis*), and the periodical Cicada (*C. septendecim*). Then follows a large number of interesting notes on various insects, an account of two injurious arthropods, the clover mite (*Bryobia pratensis*) and a household centipede (*Cermatia forceps*), two entomological papers of general interest, and a list of publications of the

entomologist. The whole volume shows the same careful preparation as its predecessors, and is well illustrated, a number of the figures being new.

**Notes on the Clover Mite.**—This little creature (*Bryobia pratensis*) has been extremely abundant during the past spring at Hanover, N. H. It appeared in swarms early in April, congregating on window-sills of houses and other buildings, and continued abundant until early in June. In Dr. Riley's recent Insect Life article upon the species it is surmised that at the north the mite passes the winter in the egg state, but this evidently is not the case in the latitude of Hanover.—C. M. W.

**Entomological Notes.**—A bulletin (No. 19) of unusual interest comes from the Colorado Experiment Station. It contains Prof. Gillette's "Observations Upon Injurious Insects, season of 1891." It includes discussions of the fruit-tree leaf-roller (*Cacoecea argyrospila*), box-elder leaf-roller (*C. semiferana*), grape-vine leaf-hopper (*Typhlocyba vitifex*), gooseberry fruit-fly (*Trypeta canadensis*), imported currant borer (*Sesia tipuliformis*), and several others. There are twelve good illustrations, all but one being original.

Number 4 of the current volume of the Ohio Station Bulletin contains an extended discussion of the "insects which burrow in the stem of wheat." by Mr. F. M. Webster. Eight species are enumerated.

At the next meeting of the Association of Agricultural Colleges and Experiment Stations, Chairman Lawrence Bruner, of the Committee on Entomology, proposes to describe the working facilities, library, collections, equipment, etc., of the various entomologists represented in the Association.

Prof. S. A. Forbes, in charge of the entomological exhibit at the World's Fair, is endeavoring to get together a biological collection of all the insects whose life histories have been worked out in whole or in part by the experiment stations.

In Bulletin No. 19 of Hatch Experiment Station of Massachusetts Prof. C. H. Fernald has published an excellent account of the present status of the gypsy moth (*Ocnerea dispar*), illustrated by an admirable colored plate showing the various stages of the moth, a map of the

region infested in 1891, and four reproductions of photographs of the effects of the caterpillar's work. The same bulletin contains an account of certain cranberry insects and of various entomological experiments.

In the April, 1892, issue of *Entomologist's Monthly Magazine* Dr. E. Bergroth describes as *Dulichius wrongtoni* n. sp. an ant-mimicking hemipteron found in India. It mimics the Indian ant (*Polyrrhachis spiniger* Mayr), to which it is said to have a most striking resemblance.

In the same issue of the same magazine Mr. Chas. Fenn describes "the pole system" of collecting Tortrices. It consists essentially of the use of a net of large diameter on a very long pole made of jointed bamboo rods, by means of which small moths flying about the tops of trees can be captured during the day.

## SCIENTIFIC NEWS.

—THE attempts made in past years by the paleontologist of the U. S. Geological Survey to prevent other paleontologists from making collections in the west are now familiar to most of our readers. A recent enterprise in this direction quite equals any of the former ones in effrontery. We learn on the best authority that Prof. O. C. Marsh has been pursuing his old tactics in the case of Prof. Osborn, of the Museum of Natural History of New York. He commenced his attack, as heretofore, by charging that dishonest methods were employed by the Professor of the Museum in obtaining specimens which really belonged to him, Prof. Marsh; and so to damage the character of Prof. Osborn with the management of the museum. These charges having been refuted, he proceeded to inform the trustees that he could not, as Government paleontologist, permit collections to be made on Government land. This not producing the desired effect, he preferred a claim based on scientific comity that he had a fair right to exclusive work in the Laramie field. The trustees of the museum failed to see the justice of this proposition, even if the claim of priority were true, which it is not. Prof. Marsh then descended to other and quite childish forms of appeal not necessary to mention here.

It remains to be seen what the U. S. Geological Survey will do with this psychological phenomenon. The demonstration of Prof. Marsh's unfitness for the position is now ample, and more is to come. But apart from all personal characteristics, such as are above described, we think it would be well if the Government material could be properly worked up and reported on. His only volume published by the present survey, that on the Dinocerata, is a good example of perfunctory work. Of the, say twenty-seven, species included in it, the remains of but one or two are described from the material actually enumerated by Prof. Marsh, the remainder of the work being left to some successor who may feel disposed to attempt a task for which all the credit has been already assumed by another. The neglect of other authors displayed in all his writings become more conspicuous recently, is also reason enough for the withdrawal from him of the aid and countenance of the U. S. Geological Survey.

—M. FRANCOIS BOCOURT, the distinguished author of the Herpetology of the Mision Scientifique de Mexique, has been retired from his

position in the Museum of Natural History of Paris. He is replaced by a retired officer of artillery, whose fitness for the place remains to be demonstrated. M. Bocourt, besides his special zoological knowledge, is an admirable artist, and his plates of reptiles are the most beautiful and accurate ever published. His retirement is greatly to be regretted, and the suspension of his work before completion will be a discredit to France. It is to be hoped that this action will be reconsidered, or if not, that provision will be made for the completion of his great work.

**Biology at the Leland Stanford Junior University.**—Biology had no prejudices to conquer at Leland Stanford Junior University. The President has faith in the Biological Sciences and sympathy with the laboratory methods in their study, while of the students who at the beginning applied for work in the University a fair proportion looked to these sciences for a part of their training. So, from the start, departments in biological lines were established, laboratories arranged for, and students have come forward to fill them.

Departments were established by the appointment of Dr. Douglas H. Campbell to the chair of botany, of Dr. Charles H. Gilbert to the chair of zoology, Prof. John H. Comstock to that of entomology, and of Dr. Oliver P. Jenkins to that of physiology and histology. To each of these gentlemen was left the direction and equipment of the department to which he was called. The appointments came at a time when it was impossible to predict the attendance in general for the present year, or what would be the number of students to be accommodated in each department. The pleasure of ordering a lot of new apparatus was spiced by the attempt to plan it for an unknown and an unknowable class. To attempt, for example, to order such a number of microscopes as would neither, as unused, stare one in the face for a year and reproach him for his extravagance, nor leave him to increase his work with relays of students on a short number, was a problem which demanded careful consideration. Most concluded to take their chances on the first horn of the dilemma to find themselves later hung up on the second. Thus it has turned out that some of the first orders have had to be supplemented or even duplicated.

The two buildings assigned to these departments were not originally intended for laboratories and are to be so employed only until the permanent biological laboratories shall be built, which exist in the plans for the near future. At present the departments of botany and physiology share one of the two buildings on the west side of the quadrangle. It is a stone building, well lighted, very pleasant, and with the

lecture rooms and offices, store room and large laboratory conveniently connected.

The planning of the furniture of the laboratories was left to the professors of the various departments. This necessitated the doing of a great deal of such work in a short space of time, and resulted in some delays. But when it is considered how much was to be done, both in furnishing and in getting together apparatus and books from such great distances, it is remarkable how few and short these delays were.

Notwithstanding these difficulties, work began in the departments with the very opening day. Not all orders were in, but enough were in to start things going, and where tables had not arrived the packing boxes of newly arrived apparatus were improvised for their support, and abandoned carpenter benches performed new duties, becoming daubed with paraffine, doused with alcohol and littered with interesting Pacific coast forms of animals and plants. Of these latter there is no lack. They preceded the apparatus and bid fair to keep in excess of all appliances.

The botanical laboratory is furnished with forty-one compound microscopes, including one new Zeiss stand with a series of apochromatics, also microtoms, imbedding apparatus, aquaria and the necessary glassware, sterilizing apparatus, and all the most used reagents. During the past year thirty-five students have occupied tables in the botanical laboratory.

In the department of physiology and histology thirty-two students, three of whom were graduate students, have been in attendance. For work in these subjects the laboratory is supplied with thirty-six compound microscopes, a number of dissecting microscopes, two Minot's microtomes, imbedding apparatus and material, a plentiful supply of fixing, hardening and staining reagents, mounting materials, etc. For work in experimental physiology there are provided kymographs of different forms, two registering cylinders of Ludwig's form and one for continuous paper, a pendulum myograph, apparatus for muscle and nerve phenomena, galvanometers and other apparatus for electrical experiments with nerve and muscle, oncometers, plethysmographs, various forms of electrical signals, manometers, time markers, tuning forks for time, apparatus for respiration, for the study of optical and auditory phenomena, tambours, cardigraphs, arteriographs, tonometers, spectroscope, polariscope, spectrophotometer, apparatus for urinalysis, for digestion experiments, dissecting instruments, batteries, etc.

The department of zoology has been quartered in the building at the southwest corner of the quadrangle, containing a lecture room, two laboratories, a small museum room and an office. For the work there are provided twelve compound microscopes, dissecting microscopes, dissecting instruments, collecting apparatus, museum specimens, a series of skeletons, and the other usual appliances of such laboratories. Abundant material for the work has been obtained from the coast.

Advanced work in ichthyology has a considerable stimulus in the presence of a very valuable collection of fishes consisting of over 2,000 species. These are made up in part of carefully selected species from the great collection which had accumulated at the Indiana University by the work of Drs. Jordan and Gilbert and their former students, and in great part by the deep sea dredging of the Albatross in the Pacific, made mainly under the direction of Dr. Gilbert; and in addition a considerable collection of fishes from the Sandwich Islands made by Dr. Jenkins. Thirty students, two graduate students have been accommodated in the department.

The laboratory for the department of entomology is in one of the buildings in the west end of the quadrangle. Prof. Comstock was present during January, February and March of the present year; the work is carried on during his absence by an assistant. The laboratory possesses already a considerable collection of California insects, and there has recently been purchased a very valuable collection of Lepidoptera containing about 2,000 species. Twenty-three students, one graduate student, have taken the work during the year.

The number of students who have applied for work in all these laboratories has been so great that new quarters for their accommodation for the coming year have been arranged for.

The biological work of the University is to continue through the summer at the newly established Hopkins Seaside Laboratory, located at Pacific Grove, on Monterey Bay. The building, now completed, is a substantial wooden structure 60 by 20 feet, especially planned for the work, and exceptionally well lighted. It has on the lower floor two general laboratories, a library and reading room, and a store room; on the upper floor are one general laboratory and six private rooms. In all about fifty students can be comfortably accommodated. The building is a gift of the Pacific Improvement Company and the people of Pacific Grove. The general furnishing, including the pumping plant, aquaria, tables, etc., are furnished through the liberality of Mr. Timothy Hopkins. The microscopes, microtomes, collecting and

other apparatus, as well as the books used are from the University. The location of the laboratory is a most charming one, on the edge of a low cliff overlooking a beach which presents greatly varied collecting grounds. The forms of both animal and plant life are extremely rich in both number and species.

Drs. Gilbert, Jenkins and Campbell are the directors. Three classes of students will be provided for: Students in the biological sciences in the Leland Stanford Junior University; teachers and others wishing to take an elementary course, and investigators. To the last class the use of the laboratory is granted free. The first two classes pay a moderate fee to cover running expenses. Great effort is being made by the directors to get together the means for comfortable and efficient work, and everything bids fair for a profitable summer at the new workshop of science.—O. P. J.

The paleontological exploring expedition sent out by the Museum of Natural History of New York is reported to have been successful in its researches in the Puerco district of New Mexico. Dr. J. L. Wortman, who is in charge, states that the weather was very unpleasant, owing to wind, dust, heat and drought, but that many valuable specimens were obtained. He goes later to the Laramie region to collect Agathaumidæ and other characteristic forms of that horizon.

The session of the Summer School of Science for the Atlantic Provinces of Canada, which opens in St. John on Monday evening, August 1st, will, from present appearances, be largely attended. Arrangements are being made to secure the comfort of those who attend. Intending visitors should make early application for boarding houses, stating what price they wish to pay. Arrangements have been made for reduced fares by rail and steamer. A large gathering from Nova Scotia is promised, and the New Brunswick teachers are expected to be present in considerable force.—*Educational Review.*

## RECORD OF NORTH AMERICAN ZOOLOGY.

*Continued from Vol. XXVI, p.* 395.

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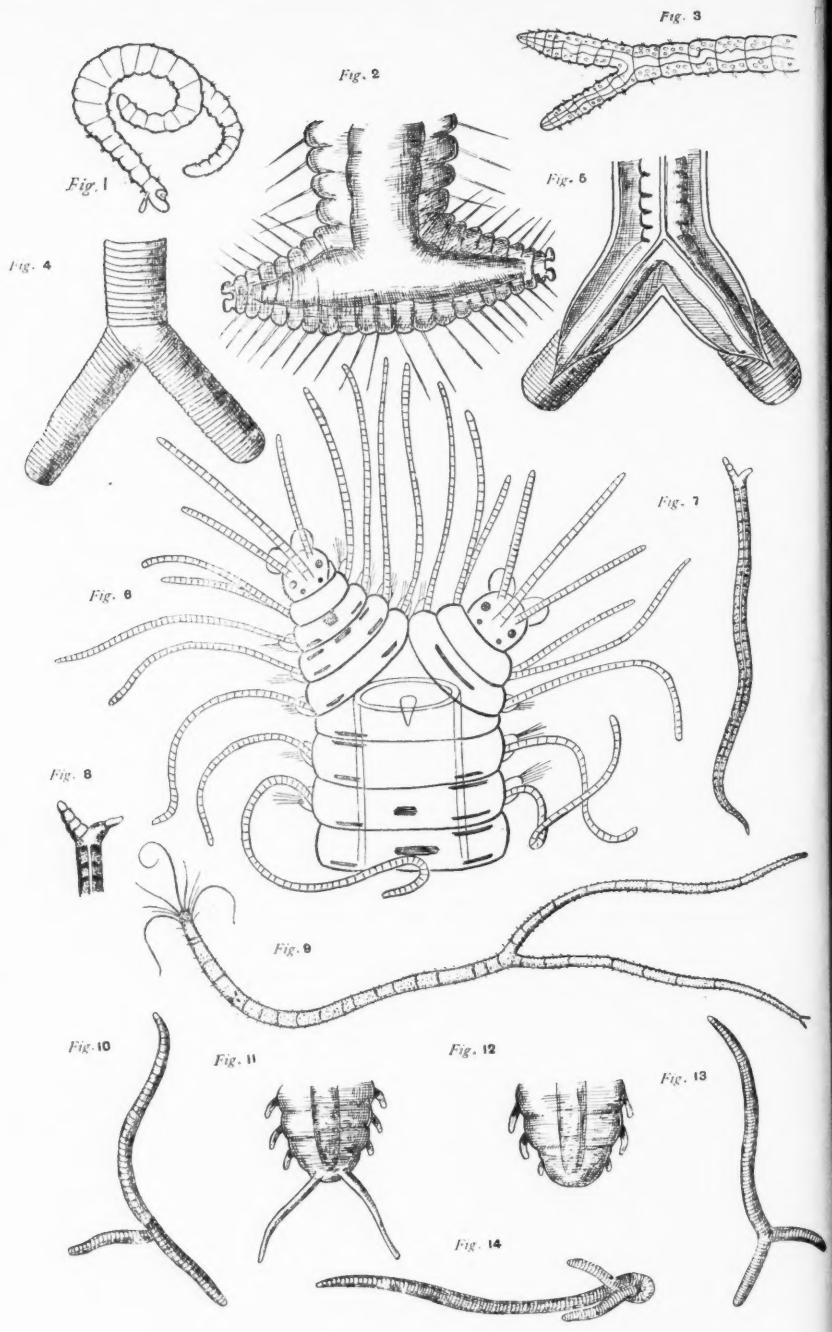
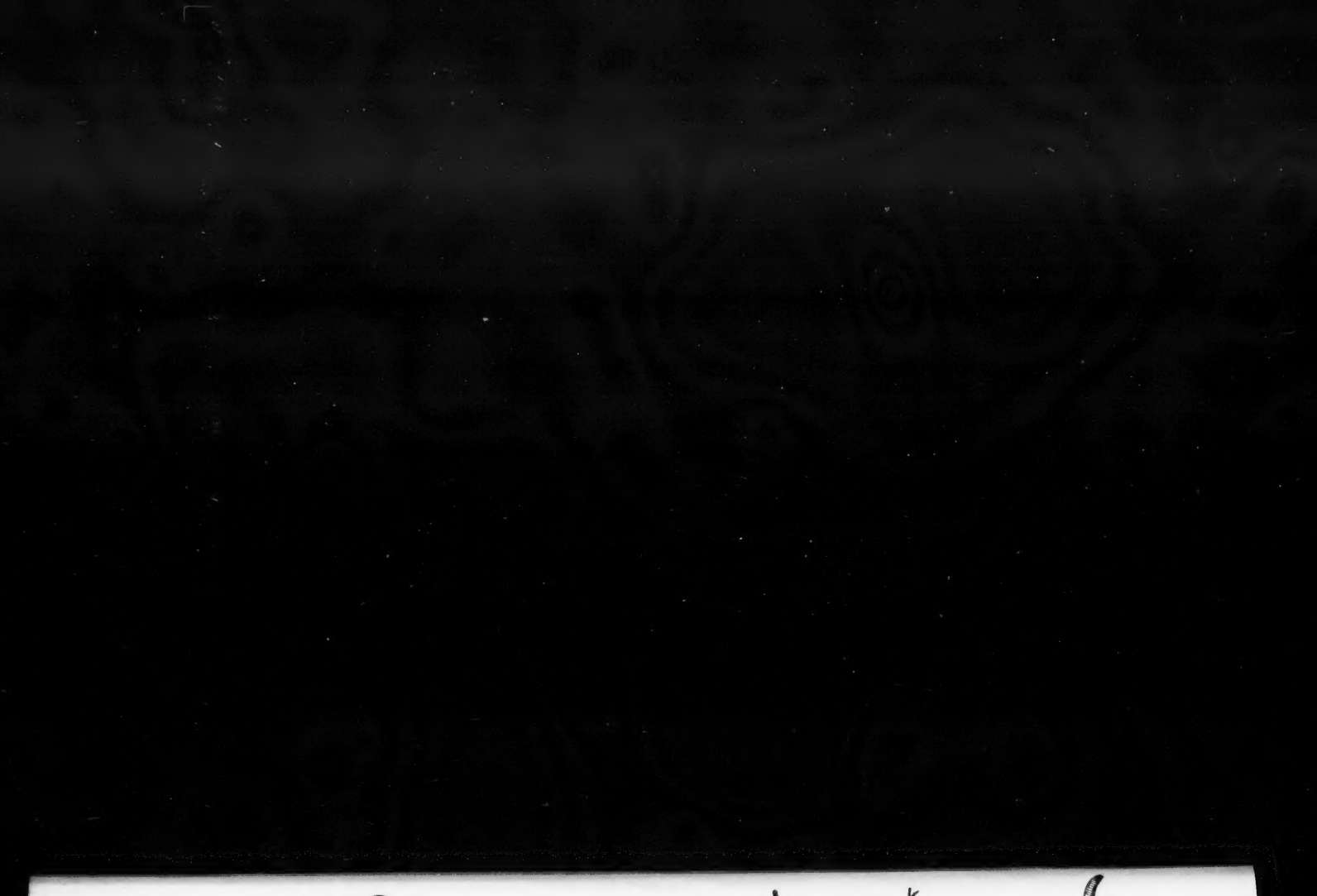
# PLATE XXI.




*Bifurcated Annelids.*